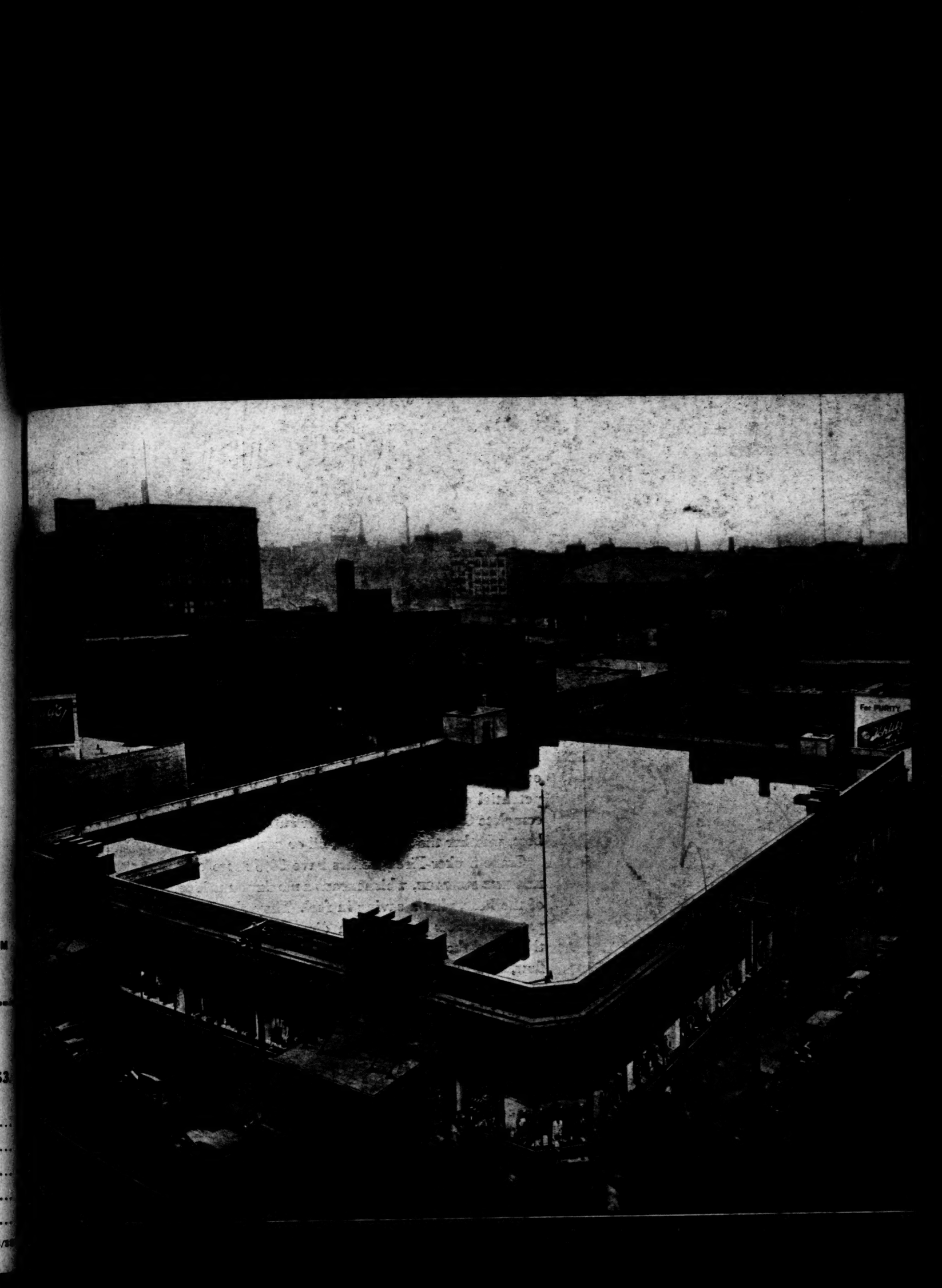

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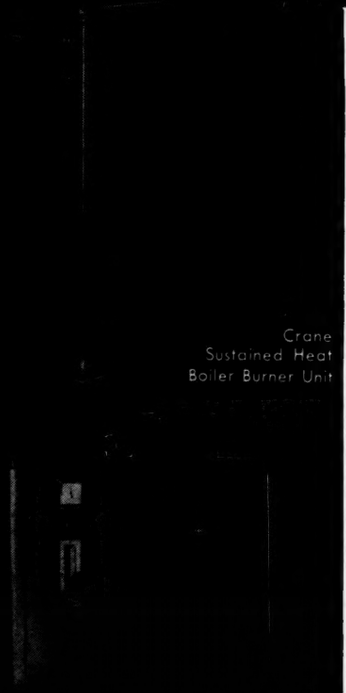

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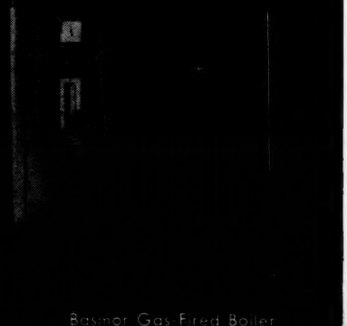

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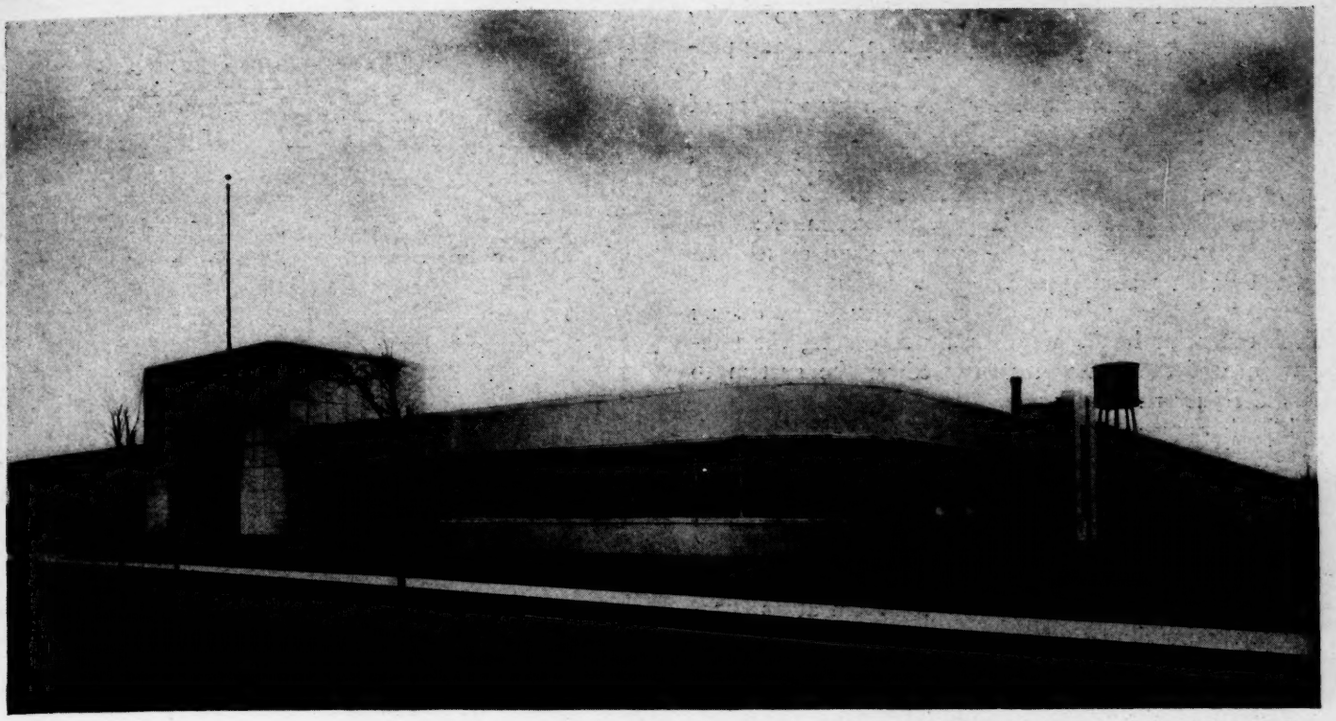


New plant of Lady Esther Manufacturing Co., Clearing, Ill.

One-Pipe Hot Water Plant for Modern Cosmetic Factory

By F. O. JORDAN†

Large ground area and low height mark this new combined office and factory building in Illinois. The heating system is modern but simple and is an example of the adoption of a one-pipe system of hot water heating for use in factory building.

IN Chicago is heard persistent talk regarding a revival of hot water heating. The heating system in the new Lady Esther manufacturing plant recently erected for the manufacture of cosmetics at Clearing, Ill., by the well-known manufacturers of feminine beauty aids is a version of this.

But it is a different version of the hot water heating than the old-timers knew many years ago. For it is a forced circulation hot water system featuring a one-pipe main which is installed overhead, or along the walls or partitions, or in fact in any available location. Specially constructed baffled fittings known as "shunt tees," are installed in this single main with separate supply and return branches for diverting a portion of the hot water from the main as required for each radiator, and for returning the water to the main after it has passed through the radiator.

The baffles in the shunt tees which are used for diverting or shunting water from the mains to radiators are arranged to take water from the top of the main where it is hottest, while the shunt tees through which the water is returned from radiators to the mains are designed so that the water from the radiator is returned to the bottom of the main where it is coolest. This effect is obtained whether the radiator is above or below the main, as indicated by Fig. 1.

The area presented by the baffle to the water stream in the main for diversion of water from or for returning of water to the mains is the same as the branch opening from the shunt tee. Since the size of the branch opening is selected to suit the size of the radiator which it is to supply, this feature assures that the baffle is properly designed to circulate the proper quantity of water through the radiator.

If required because of short branch runs, an additional refinement in balance is obtained by bushing the branch outlet and reducing the branch connections to the radiator so that the resistance of the short branch circuit may be increased to prevent an excess supply of water from flowing through it.

Because of the installation of only one main at which all branch circuits have both their origin and their ending, short circuiting is impossible, while branch circuits

†Detroit Consulting Engineer, and Manager of Edit. and Cons. Depts. of Refrig. and Air Cond. Inst., Chicago.

may be added or taken away at will without possibility of destroying the balance of the system, or of any portion of it.

One advantage claimed for this particular type of forced hot water system is its low cost as shown by the fact that the Lady Esther installation is said to have been installed at a total cost comparable to that of a one-pipe gravity steam heating system. Another is the advantage inherent in any properly designed and installed hot water system, which is that even room temperatures may be maintained throughout, during both severe and mild weather, by regulating the temperature of the hot water supplied to the system to suit the current weather.

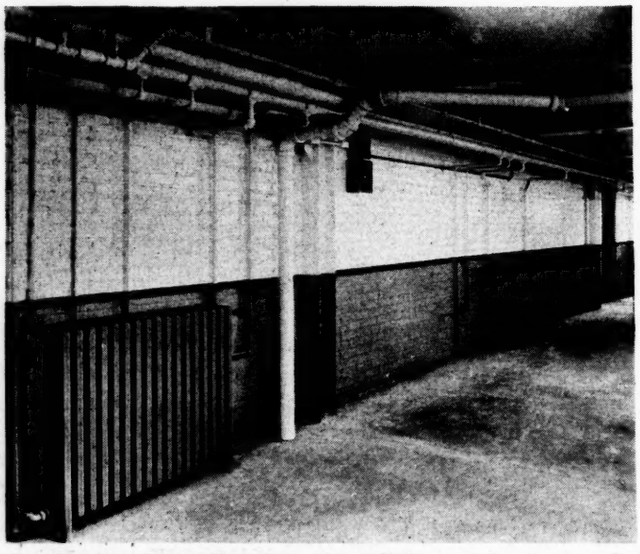
The heating system consists of two oil-fired, Scotch marine boilers designed for hot water heating service, and two motor-driven hot water circulating pumps, together with the one-pipe main and its shunt tees and branches as previously described.

The boilers and pumps, together with the closed expansion tank, are located in a boiler room at one corner of the building.

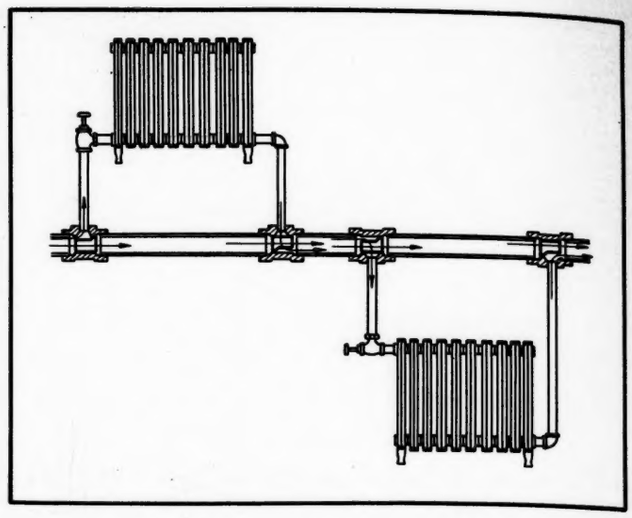
The shipping and receiving areas are heated by overhead blower type unit heaters, which are served by a forced circulation, conventional two-pipe hot water system with reversed returns, which was used in this case instead of the one-pipe system installed in the remainder of the building because shunt tees are not yet available of sufficient size for serving these unit heaters.

The remainder of the building is heated by direct radiators on a one-pipe forced circulation hot water system. Radiators in private offices are concealed type, while radiators in other offices and in manufacturing areas are cast-iron tubular type.

The one-pipe main for the first floor office radiators is installed in a trench under the floor. All other mains are located at the walls, rising above obstructions and being offset below them as required to avoid interference, with no ill effects upon circulation. Some radiators are located above the mains, while others are located below them. At certain skylights, radiators are located at various elevations, often a considerable distance from the mains.



Overhead main feeding down to radiators and using special tees to secure flow.



Diagrammatic view showing special tee fittings for diverting part of the water from main through radiators.

An interesting feature of the piping system is that since the building is 200 ft. wide by 540 ft. long, more than 500 ft. of one-pipe main intervenes between the boilers and the most distant branches.

The piping system is zoned for future automatic zone control which may readily be installed at any time when and if desired.

There is in all, approximately 40,000 sq. ft. of equivalent direct steam radiation installed, at a rating of 240 B.t.u. per sq. ft. per hr. Because of the baffling arrangement of the shunt tees which results in supplying each radiator from the top of the one-pipe main where it is hottest, and returning the relatively cooler water to the bottom of the main where it does not disturb the natural temperature stratification of the water in the main, it is said to be unnecessary to base radiator selection upon circulating progressively cooler water through radiators, according to the practice necessary with certain types of one-pipe hot water heating systems.

Design is based upon a water temperature drop of 10F through unit heaters, 20F through direct radiators, and upon a water pressure drop due to friction through the piping system of 400 milinches per ft.

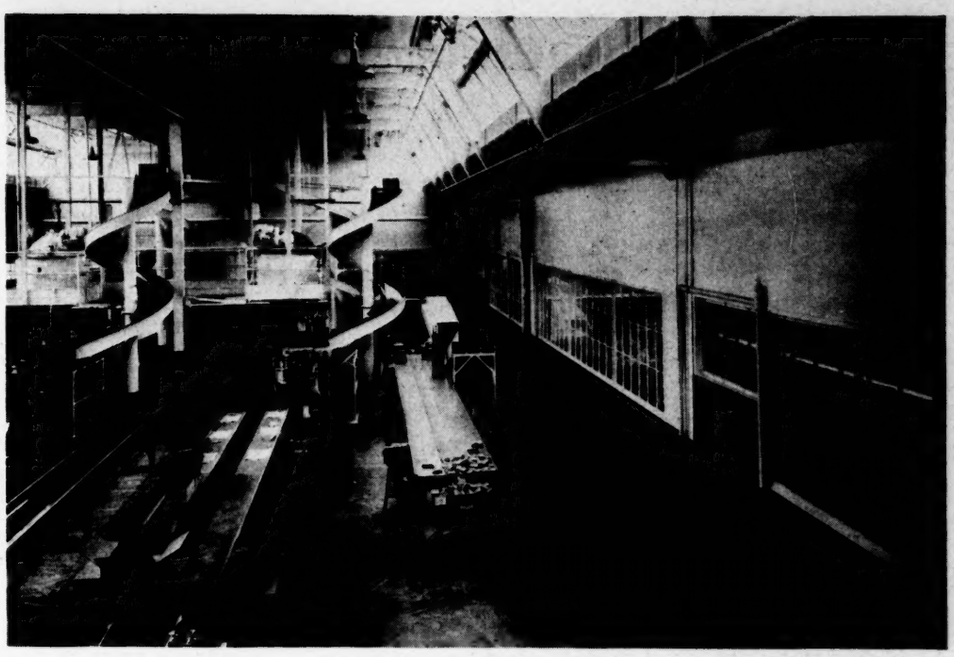
The 125-hp. boilers are fired by industrial type oil burners, operating under automatic control by means of which the hot water leaving the boilers is held at a predetermined temperature as best suited to the existing weather. Fuel oil circulating pumps are provided in connection with the oil burners.

Electric oil heaters are installed for use during starting-up periods, while steam oil heaters are installed for service during regular operation.

The unit heaters are overhead blower type of 1100 sq. ft. E.D.R. each. Fan operation for each unit heater is under the control of a thermostat, which may be adjusted to maintain the desired room temperature.

The hot water circulating pumps are centrifugal type, each having a rating of 900 g.p.m. against a total system heat of 100 ft.

This system has now seen service throughout the past heating season, having been placed in service on November 1, 1937.



Radiators equipped with raised legs to permit main to pass under and along floor. Note how main passes doorway in foreground.

The owners have stated that operation has been satisfactory throughout the season, as the desired temperatures were maintained throughout all heated areas, while the system has demanded no attention other than that which is naturally attendant upon operation.

In fact, it is declared that no adjustments even in the nature of balancing of the system have been required either at the initial starting up of the system or at any subsequent time since installing.

Albert Kahn, Inc., Detroit, represented the owners, while the heating system was installed by the Kehm Bros. Co., Chicago heating contractors.

Growing Plants Without Soil

IN California, as the result of the work of Dr. Gericke, vegetables and flowers are being grown in tanks of water without any form of soil, reports Arthur D. Little, Inc., in the "Industrial Bulletin." Two growers are producing tomatoes on a commercial scale at Capitola and Montebillo by this method, and the technique is being investigated for commercial flower growing at Richmond and for strawberries at Watsonville.

The idea of water culture, as it is called, is not new, having been first mentioned some three hundred years ago. At about that time a willow tree was grown in water to the age of five years. The California work, which has been going on for seven years, has carried this idea through to a commercial basis. Beets, turnips, carrots, celery, cucumbers, papayas and such flowering plants as gladioli and sweet peas have shown amazing growth and yield when grown in this way.

The plants are set for support in a bed of excelsior or moss spread on a wire screen tightly stretched over shallow tanks. The roots extend down into the water to get their nourishment from the proper chemical elements added in aqueous solution as required, or from fertilizing units consisting of 1-lb. containers of the chemicals which gradually diffuse into the tank. Among the advantages are the density of the stand of plants that is possible, freedom from soil pests, and longer periods of bearing. Astonishing yields have been recorded. Tomatoes in commercial production yielded 217 tons per acre of tank surface per year, and it is said that they were of exceptional quality. Potatoes have yielded at the rate of over 2400 bushels per acre. This compares with the 1934 United States average of 116 bushels. It has been estimated by Dr. Gericke that a probable yield of one ton of tomatoes per 100 sq. ft. of tank area is possible if ample room for upward development of the vines is provided for.

Such results are obtained by careful control of the growing solution and also of the tank temperature when off-season production is desired. In unheated greenhouses where tank temperature was maintained at not below 70 to 75F, with air temperature varying from 50 to 84F, tomato plants grew to a height of 25 ft. and first fruit appeared six weeks ahead of that from plants in unheated tanks in the same room.

Of interest is the consumption of electrical energy for heating. It is reported that the tomato operation at Capitola, conducted in a double-unit 80 x 200 ft. greenhouse containing 66 tanks 25 x 2.5 ft., has a connected heating load of 150 kw. and consumed about 30,000 kw-hr. per month during the winter.

It is stated that the chemicals used in water culture are low in cost and mostly products of the heavy chemical industries. Inasmuch as little has been standardized, the item of labor for such intensive farming is not yet known.

Radiant Heating Today

By T. NAPIER ADLAM†

AFTER an absence of nearly five years, it was very interesting again to visit England and make a cursory survey of the progress made in the designs and applications of radiant heating. It was certainly obvious that not only had radiant heating held its own, but that it is becoming increasingly popular and more installations are being erected each succeeding year. Some few years ago only a small number of heating contractors ventured in the erecting of these systems, but that has changed, for since many of the manufacturing firms in England are now turning out radiant heating units of various designs for the trade, it is very easy for the smaller heating contractors to install systems of this type.

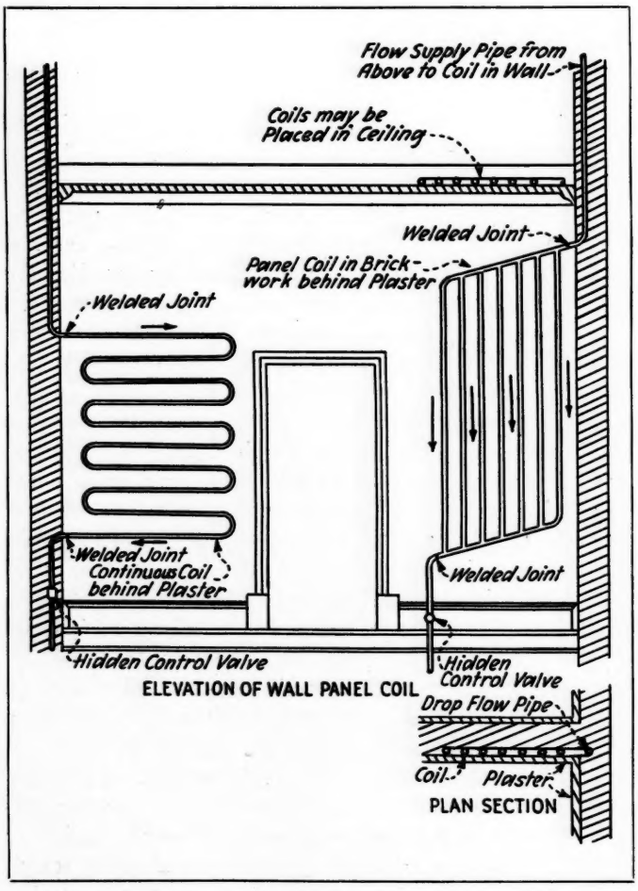
While the original method of embedding pipes in the plaster of walls and ceilings is still popular for many high class buildings where radiant heating systems are being installed, it appears that greater strides have been made in the manufacturing and application of metal surfaces for radiant heaters, either cast in sections or constructed with flat sheet metal surfaces backed with pipe coils or channels for steam or hot water.

One of the largest manufacturing firms of boilers and radiators in England, that has been manufacturing various forms of cast iron radiant heating units for over fifteen years, stated that the annual output of these heaters has been increasing the whole of the time and is still on the upward trend. The consensus of opinion obtained from those engaged in this industry unquestionably indicates that radiant heating is giving entire satisfaction, and produces all the advantages claimed.

As regards the efficiency claimed and the resultant saving in fuel consumption, this also seems to be well established and savings of 30%, and sometimes more, over ordinary heating can be achieved. This same manufacturing firm stated that in their opinion a large saving in fuel consumption must be obtained, because with all radiant heat systems, they reduce the boiler capacity by 40% below that required for similar jobs where ordinary cast iron radiators or convected heaters are used. Seeing that hundreds of these systems are sold every year, this seems to be sufficient proof of the saving effected.

In presenting a picture of the activities going on in England in connection with radiant heating, it may be

†*Chief Engineer, Sarco Co., Inc.*



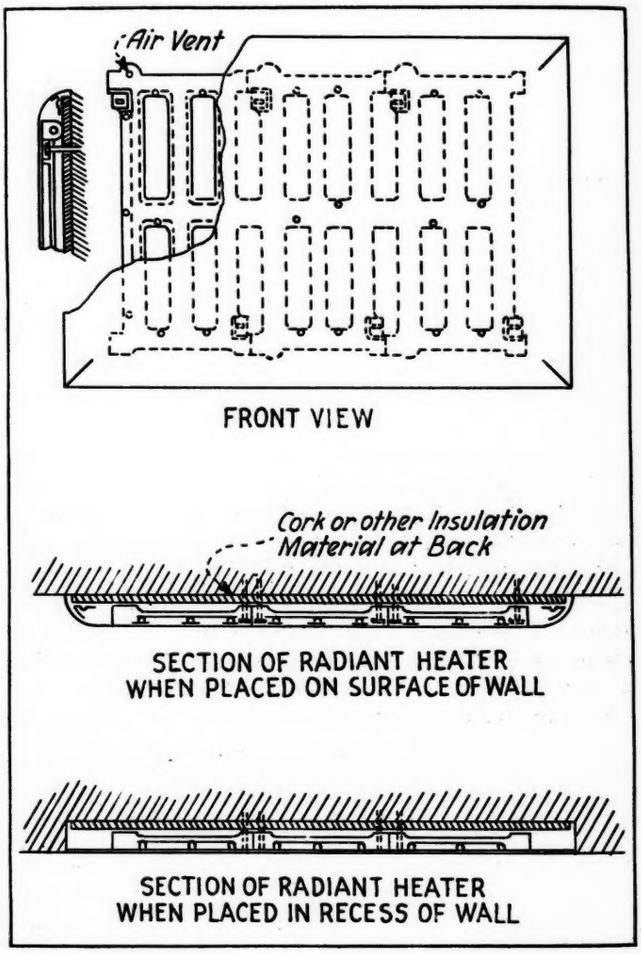
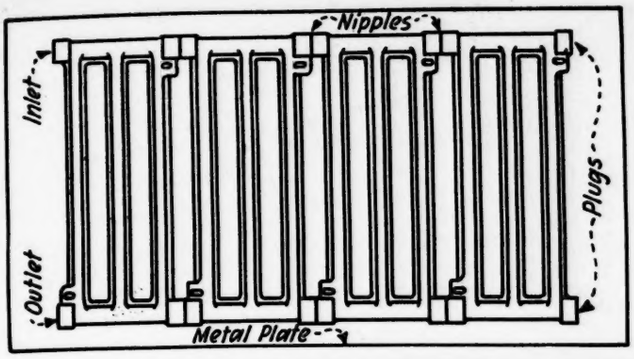

Air Vent
FRONT VIEW
Cork or other Insulation Material at Back
SECTION OF RADIANT HEATER WHEN PLACED ON SURFACE OF WALL
SECTION OF RADIANT HEATER WHEN PLACED IN RECESS OF WALL

Fig. 1 (Left). Typical coils in sidewalls of room. Similar coils can be placed in ceiling. Fig. 2 (Right). Front view and sections of iron radiant panel.



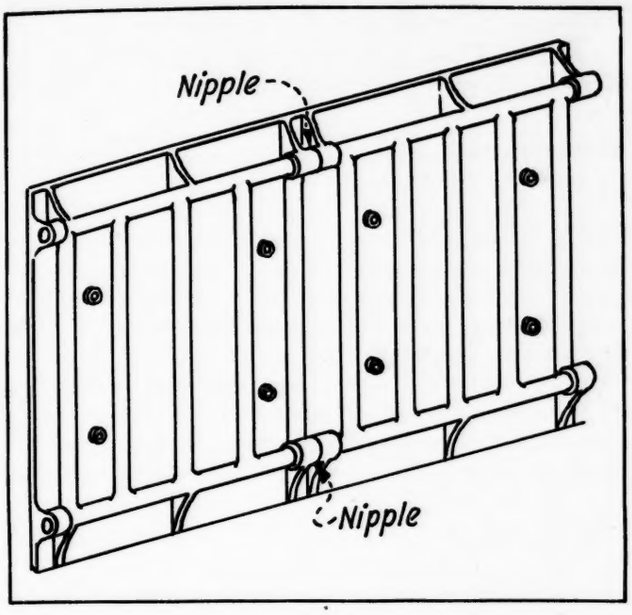
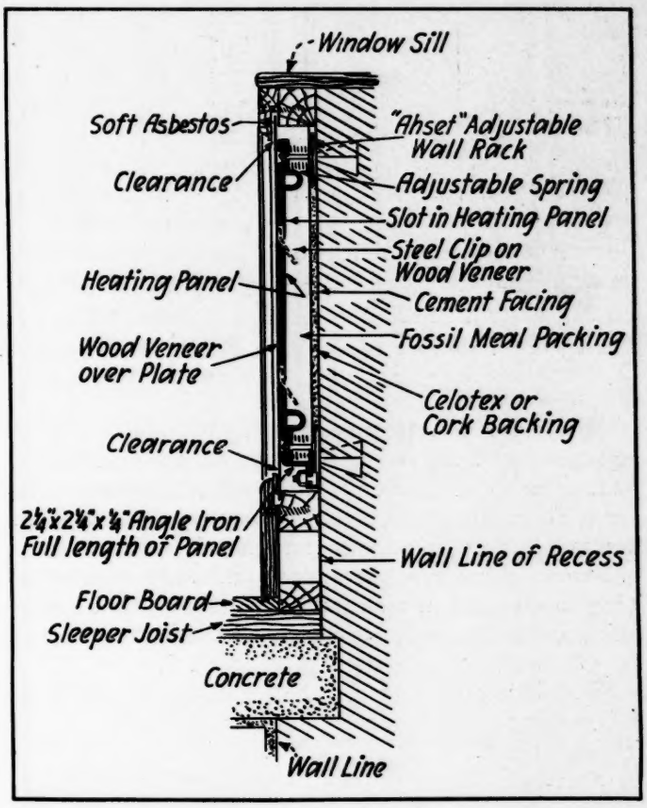


Fig. 3 (Upper left). Back view of iron radiant panel. Fig. 4 (Below right). Section showing arrangement of accessible radiant heat panel below a windowsill. Fig. 5. (Lower left). Back view of another type of radiant panel showing waterways.



interesting to review the various methods now in common use with their respective advantages and means of application.

Embedded Pipes

This method is probably better known as the "panel" system and comprises pipe coils embedded in the concrete or plaster of walls and ceilings, the heating medium being hot water circulating through the pipe coils. These coils are generally constructed with ½ in. wrought iron pipe spaced about 6 in. apart and the coils can be either formed as a continuous circuit or in grid form.

Fig. 1 illustrates both methods of forming the pipe coils and these can be placed in the ceiling or in the wall. This has the effect of warming the entire concrete or plaster surface in which the pipes are embedded and since the highest water temperature permissible with this method is 120F, sufficient surface has to be heated to give the desired results. The pipe coils are made at the factory and tested before erecting, the system is then erected and coupled up to the circulating mains using welded joints throughout.

Each coil is tested at the factory to a pressure of 500 lb. per sq. in. and after erection the whole system is tested hydraulically to a pressure of about 300 lb. and carefully inspected while under pressure. If it is a large job, the test is first carried out in sections and then a complete test on the whole system, after which the plaster is covered over the pipes and the decorating completed. The "panel" system is used in many of the better class buildings such as apartment houses and large offices.

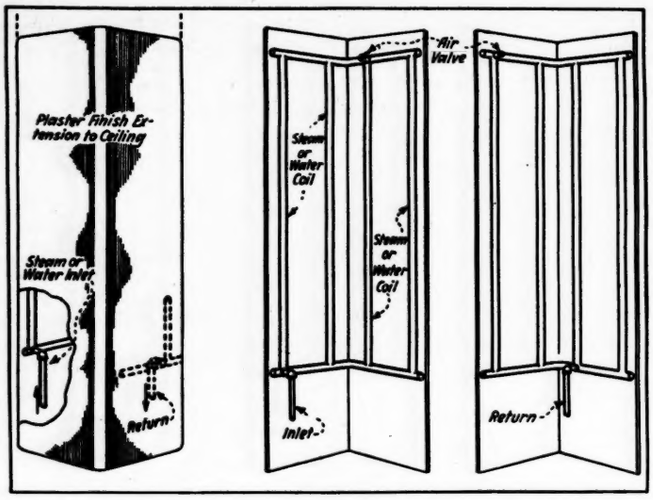
Cast Iron Radiant Panels

Figs. 2 and 3 illustrate an iron radiant panel in which the circulating coils are cast in sections with assembling nipples used for coupling any number of units together to obtain the size required, as with an ordinary cast iron radiator. The flat surface plate is made the correct size necessary for the room or position, and is fastened to the cast iron coils to form a complete unit. The advantages of these units are that they can be used for steam or water, can be easily repaired in case of leakage, and alterations to the room may be easily made since they can be taken down and moved in the same manner as ordinary cast iron radiators. These are connected up in exactly the same manner as cast iron radiators.

Fig. 4 illustrates the method of installing these in a recess under a window where a molding is formed around the edges to give it a very good appearance and allow for expansion. These units can also be placed on the face of the wall or may be placed on the ceiling with a suitable moulding to make a good finish.

Many schools and public buildings in England are fitted with these units where it is essential to have efficient and quick heating with plenty of ventilation.

Fig. 5 illustrates another type of radiant panel which is also being used very extensively. With this design the coil or passageways are cast integral with a smooth



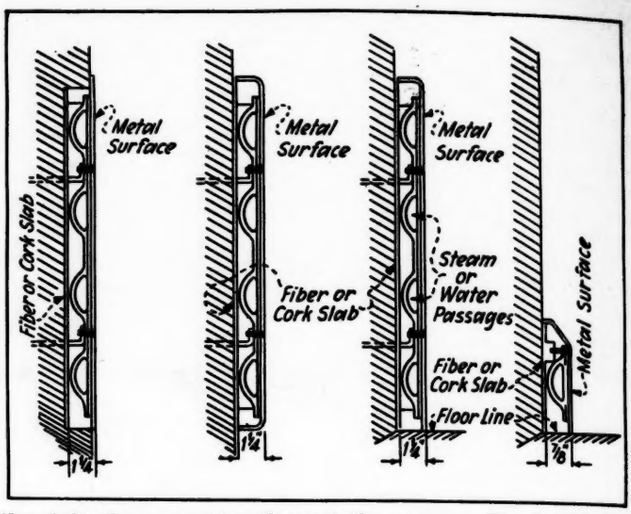


Fig. 6 (Left). Column type radiant heater. The two views to the right show a section through the corners. Fig. 7 (Right). Section of border panels, another type of radiant heater.

metal surface and assembled with right and left handed nipples. The units are cast various heights and can be built together to give any length desired. These units are effective and cheap. The author while in England designed the heating system for the new English offices of Sarco Company in which these units are to be used. These are placed in a recess in the wall with a suitable finish around the sides to harmonize with the finish of the offices similar to that shown in Fig. 4.

Fig. 6 illustrates a rather unique radiant panel which is becoming popular for large offices and stores. It is fabricated into a column type radiant heater. These can be placed in the center of a large room or any other convenient place with connecting pipes through the floor. This provides heat in large spaces without producing any unsightly appearance, as the column is extended to the ceiling.

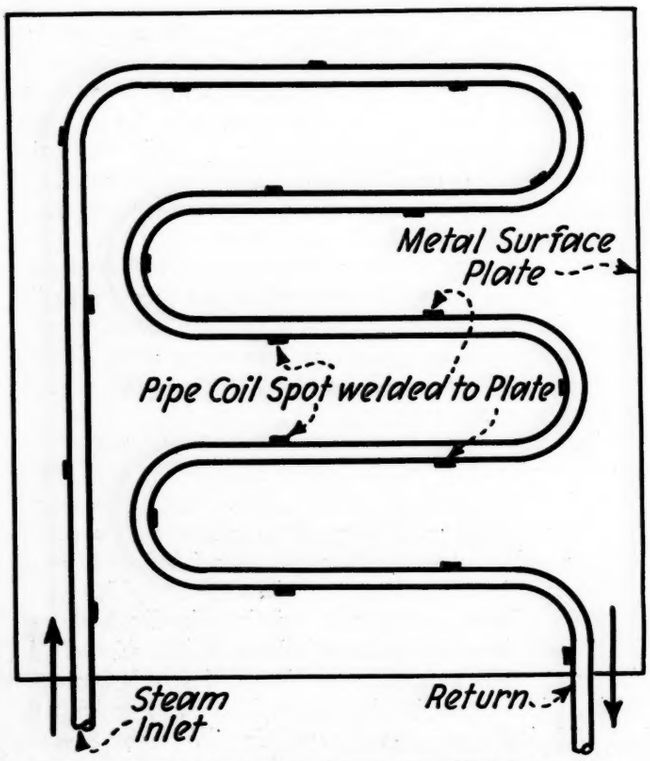


Fig. 8. A type of radiant panel assembled from pipe.

Fig. 7 illustrates another type of radiant panel in which the steam or water passages are formed by welding "D" section drawn tubes to a steel plate. These are made to the exact size required and coupled up as an ordinary radiator system.

Fig. 8 illustrates a very common and easily constructed type of unit and is assembled with ½-in or ¾-in. steam pipes formed into a coil and spot welded to a metal plate which forms the radiant surface. These coils and iron plates can be made any size to suit the positions and can be finished to give a good appearance and painted to harmonize with the decorations of the room. The author has already installed a number of these panels in our offices at Bethlehem, Pa., with excellent results.

If it is desirable to have a better appearance than the iron surface, as may be the case in residential buildings and high class offices, the iron panels may be covered with a very thin veneer.

In England there is a unit specially constructed for veneer and known as the "Veneeray." The heater is constructed in sections and after installing, the veneer is placed over the whole surface with molding to harmonize with other wood panels in the room. This finish can, of course, be applied to any of the metal units illustrated.

In addition to the foregoing there are many installations where the floor only is heated with hot water coils under the floor, while other systems, such as the one at Liverpool Cathedral, are heated with warm air passing in ducts formed in the floor construction.

While with all of these radiant methods except the "panel" system steam or hot water is being used, the author finds that quite a number of electrical radiant units are also being used. The advantages of electrical units are that they can be easily controlled and can be placed in any position without considering run of steam or water pipes.

In the author's opinion, the great strides made in England with radiant heating are due largely to the progressive spirit of the heating contractors, consulting engineers, and architects. Once the heating contractors or engineers in England decide on the best type of heating for their clients, the manufacturers invariably fall

into line and produce the goods. When the first radiant heating system was installed in the Liver Building at Liverpool, England, over twenty-five years ago, Messrs. Crittall of London made a bold adventure when installing such a large system without previous experience, because had it been unsuccessful, it would have been a very disastrous undertaking for the firm, owing to the size and importance of the building. While A. H. Barker deserves full credit for this success, since he designed the whole system without any previous job upon which to base his calculating, it was Messrs. Crittall and Company who shouldered the responsibility. However, as the first job was a complete success, Messrs. Crittall has been in the forefront of radiant heating ever since and other firms are now finding good business in erecting systems of this and other designs to share in the reward of this first adventure. One manufacturing firm has had one large shop working continuously for the last two years making pipe coils only for embedding in plaster. Firms, who have never before attempted to manufacture heating units, are now manufacturing radiant heating panels in either cast iron, wrought iron, or steel, trying to share in the ever-growing demand for heaters of this type.

Design of a Modern Coal Bin†

By KENNETH R. HARE‡

IS it necessary that the hand firing of solid fuel be so much of a drudgery? Does it have to be as dirty? We have given considerable study to this problem and find that a great deal can be done to make the hand firing of solid fuel easy, convenient, and clean. Once we get the hard work and the dirt out of hand firing it is an easy step to a modern basement with a recreation room. And, of course, there is no reason why modern air conditioning cannot be used with hand fired solid fuel.

Let's take attractiveness first. To make a place attractive, whether it is a basement or any other place, it seems to me the first thing we have to do is clean it up. What makes the average basement dirty? The two worst offenders in this respect are the dirty, old-fashioned, dusty fuel bins and the handling of the ashes.

The one thing about a hand fired solid fuel basement which causes more work, more steps, more dirt and which is the most unsightly thing in the basement is the average solid fuel bin. What can be done about it? A great deal. It is not much of a job nor very expensive to install a sloping bottom. Once this is done, the door can be nailed shut. The bin can be built up to the ceiling and made dustproof all around. Nobody ever has to walk into it, and the outlet can easily be made to keep the fuel from coming out on the floor. The whole thing then becomes a piece of apparatus which at once takes practically all the drudgery and dirt out of hand firing with solid fuel. A sloping bottom will reduce the average bin capacity by 10% or 15%, but this amounts to only a dollar or two per year in summer savings, which is cheap convenience.

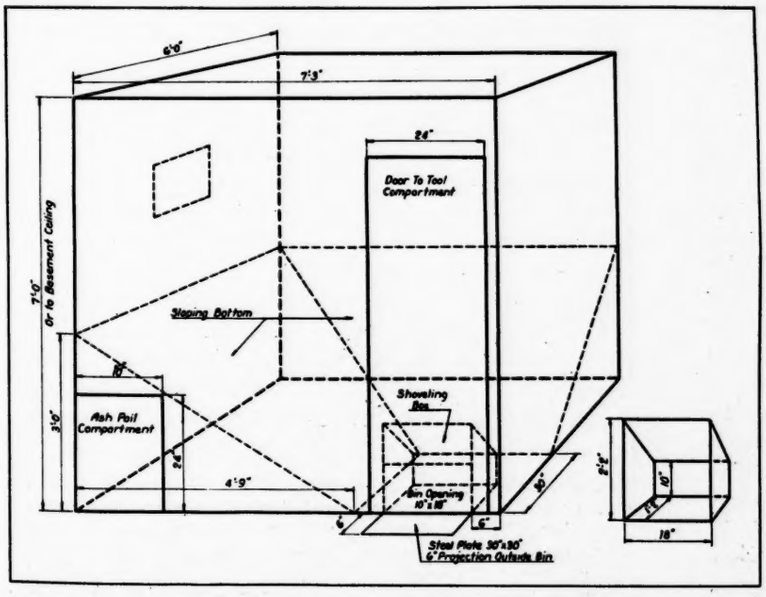
To be ideal, it may be desirable, in some cases, to change the location of the bin when making these alterations. Our survey in over 1300 basements indicated that only 18% of the fuel bins were within 3 ft. of the furnace, 57% were between 3 and 10 ft., and 16% between 10 and 15 ft. I believe it is more important to the customer to have the bin near the furnace than near a window for convenient delivery. Maybe, in some cases, it would be worth while to move the furnace itself. Why not? If the furnace is way out in the center of the basement, it would not be possible to modernize the basement even by installing an oil burner.

Now we come to the other dirt bugaboo —the handling of the ashes. Can we clean up that job without a lot of expensive machinery? How about a water sprayer in the ashpit so that the dust is laid before the ashes are handled?

There are several such sprays in use. However, we do not know of any which have been placed on the market at a reasonable price and advertised to the general public. The ashpit spray we have designed is a simple brass and copper device which can easily be attached to any convenient water pipe. By turning a valve, a fine stream of water is sprayed over the ashes without touching the grates, thus wetting down all ash dust. The whole thing is installed for approximately five dollars.

†From a paper presented at the 5th annual convention of the Fuel Merchants Association of New Jersey.

‡Sales manager, Koppers Company, Kearny, N. J.



Sketch of the self-emptying fuel bin. Framework of 2 x 4's, tongue and groove or shiplap for the walls, covered with wallboard and with galvanized sheeting for the sloping bottoms.

Cost, Construction, and Installation of Evaporative Condensers

By RICHARD E. HOLMES†

THE medium used to carry away the heat being removed from an air conditioned space by a refrigeration machine must be plentiful, cheap, and convenient. Only two media fulfill these requirements; they are air and water. Three types of condensers make use of these media today: (a) the air cooled condenser, (b) the water cooled condenser, and (c) the evaporative condenser which is a combination air cooled and water cooled condenser.

Relative Initial Costs

Depending upon the geographical location as well as upon the type of building and the part of the building in which the refrigeration machine is to operate, the three types of condensers fulfill these requirements to different degrees of satisfaction. In general, air is always more plentiful and cheaper, in that it is always free. However, the use of air as a cooling medium involves the use of a fan and a motor which adds an item to the operating expense and increases the initial cost of the condenser.

The initial cost of an air cooled condenser is usually greater than for a water cooled condenser. The former requires more material for the cooling surface because the rate of heat transfer from metal to air is much lower than from metal to water. The net material cost is usually less for the air cooled condenser, however, because it may be made of steel whereas the water cooled condenser must be made of more expensive, non-corrosive metals such as copper, brass, or aluminum. The initial cost of an air cooled condenser is greater because a fan and motor are required to move the air, whereas city water pressure usually furnishes the energy to move the cooling water through a water cooled condenser.

A refrigeration compressor using an air cooled condenser is less efficient than one using a water cooled condenser because the temperature of the air is almost always considerably higher than the temperature of available cooling water. Lower refrigeration machine efficiency means less cooling capacity and a greater electrical energy cost because of the energy required to drive the condenser air fan. If the water cooled condenser is used, the electrical energy cost will be lower, and greater cooling capacity will be obtained because of the higher efficiency of the compressor. The cost of operation per B.t.u. of cooling will be less with the water cooled condenser as long as the cost of water is low enough. If, however, the cost of water exceeds a certain minimum, which can be determined for any given installation and which depends upon the relative cost of electricity and water, then an air cooled condenser could be operated cheaper than would the water cooled condenser in this particular installation.

†Air Conditioning Engineer, Westinghouse Elec. & Mfg. Co.

An air cooled condenser is sometimes used in cases where a water cooled condenser would be cheaper, but where the use of the latter would be impractical due to plumbing difficulties. Likewise, a water cooled condenser is sometimes used even though an air cooled condenser would be cheaper, because the refrigeration machine must be placed in a small closet space or because of some other difficult installation problem.

A combination air cooled and water cooled condenser, known as an evaporative condenser, should be used for installations where small quantities of water are available but where its cost is high. Enough added efficiency and lowered operating cost can be obtained by using an evaporative condenser rather than an air cooled condenser to justify the use of the former in practically every case of this kind. In certain localities, notably desert towns where water is practically unavailable, the air cooled condenser is the only kind which can be used.

The evaporative condenser is more expensive than the water cooled condenser; it requires a finned coil, a fan and motor, a pump and motor. The installation of an evaporative condenser is much more expensive. However, the evaporative condenser can usually be purchased and installed cheaper than can an air cooled condenser. The latter requires much more heat transfer surface and consequently a larger fan; these items more than offset the higher cost of installing an evaporative condenser and the cost of its pump and motor.

Operating Costs

Fig. 1 shows graphically a method of determining

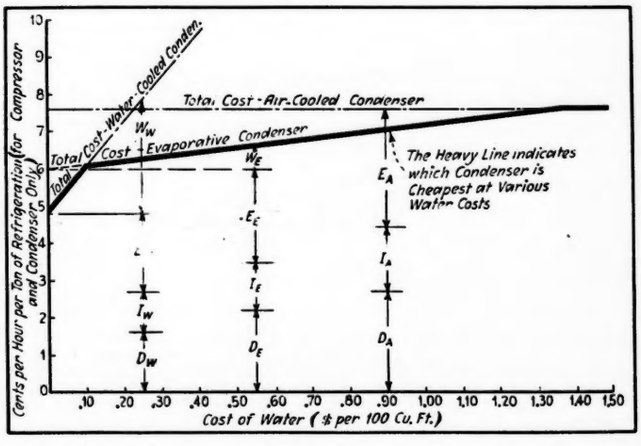

Cents per Hour per Ton of Refrigeration for Compressor and Condenser Only
Total Cost - Water Cooled Condens.
Total Cost - Air-Cooled Condenser
Total Cost - Evaporative Condenser
The Heavy Line indicates which Condenser is Cheapest at Various Water Costs
Cost of Water (¢ per 100 Cu. Ft.)

Fig. 1. Relative operating costs of compressors and water-cooled, evaporative or air-cooled condensers. Based upon 7-ton installation, electricity 2c. per kw-hr. 1000 hr. operation per year, 80F water. W = Water cost; E = Electricity cost—compressor and condenser; I = Interest on investment; D = Depreciation on investment (life 10 years); subscript W refers to water-cooled condenser; subscript E refers to evaporative condenser; subscript A refers to air-cooled condenser.

for any given locality which type of condenser would yield the lowest operating cost. Any change in the relative cost of electrical energy and water will change the water price range over which each particular type of condenser is cheapest. In general, however, the water cooled condenser will be cheapest when water rates are low, the evaporative condenser will be cheapest in the middle range of water rates, and the air cooled condenser will be cheapest when water rates are extremely high with respect to electrical energy rates.

There are other factors besides the cost of water which would affect the choice of a condenser. One very important factor is the question of the *present* and *future* availability of water. If a water cooled condenser is to be used on an installation in a city so situated that changes in city ordinances are likely to restrict the rate of drawing water from the mains or the rate of putting it into the sewers, then it would be advisable to use an evaporative condenser rather than incur the expense of changing the type of condenser at some time in the future. It is evident that the combination air cooled and water cooled condenser, known as an evaporative condenser, can be used in a large number of installations, thereby effecting a saving in operating cost.

Construction of an Evaporative Condenser

A cross-sectional view of a *typical* evaporative condenser is shown in Fig. 2. Nozzles direct a fine water spray downward onto the top of the condenser coil. The sprays are so spaced as to cover the face area of the coil with a plentiful supply of water. The water wets both sides of all the fins and the outside of the tubes as it flows down through the finned coil and drips off into the sump. From the sump, the pump returns the water to the sprays, and it again passes through the same cycle. A float valve is placed in the sump to regulate the amount of fresh city water which is brought into the condenser so as to maintain the level of the water in the sump at a predetermined height. To prevent the growth of algae and the collection of excessive mineral deposits in the sump, the float valve is usually set to maintain the water level slightly above the overflow outlet. This causes excess water to be brought in allowing some to go out the overflow pipe to the sewer, thus renewing the sump water while removing foreign matter.

Air enters the condenser through the sloping inlet near the bottom of the structure and passes first through the spray which is dripping from the bottom of the coil into the sump. It then passes over the wet fins and tubes of the condenser coil, then through the sprays, through the eliminator plates which remove any entrained moisture, and out through the blowers. A duct usually is attached to the blower outlet so as to carry the hot, humid air from the condenser to the outdoors.

The capacity of an evaporative condenser is determined by the wet bulb temperature of the entering air. If the air entering the condenser has a relative humidity of less than 100%, as it usually has, it soon becomes saturated as it passes through the water dripping beneath the cooling coil. It tends to become saturated at a temperature slightly above its wet bulb temperature, due to the fact that the water which is dripping off the condenser coil is warmer than the entering air wet bulb temperature. As the air flows upward to the coil between the wet fins and tubes, it remains in a saturated condition but becomes warmer and picks up additional moisture. It passes out of the coil through the spray and eliminators and is exhausted to the outdoors in a practically saturated condition. Its wet bulb temperature is, of course, higher than its entering wet bulb temperature. The leaving air wet bulb temperature may be determined by calculating the increase in the total heat of the air which must take place as the air flows through the condenser. This increase is based upon the B.t.u. per hour capacity of the condenser, the inlet air wet bulb temperature, and the rate of air flow through the condenser.

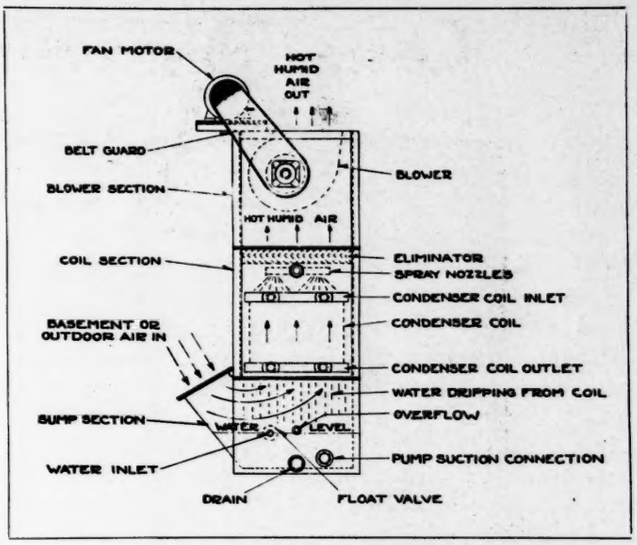


Fig. 2. Cross-section of evaporative condenser.

The water enters the sprays at its lowest temperature at any point throughout the system. It is heated first by contact with the warm air and again by contact with the warm tubes and fins of the condenser coil. It never gets as warm as the refrigerant within the tubes because of the continual evaporation of the outer film of water on the tubes and fins into the air which is passing through. The water then drips from the fins at the bottom of the condenser coil and is cooled by the entering air to a temperature slightly above the entering air-wet bulb temperature. From the sump, it is drawn by the pump and forced through the spray nozzles again at approximately this temperature.

Efficiencies of Systems with Various Types of Condensers

The evaporative condenser is more efficient than the air cooled condenser because its capacity depends upon the wet bulb temperature of the inlet air whereas the capacity of the air cooled condenser depends upon the dry bulb temperature of the inlet air. Since the wet bulb temperature is usually 5F to 20F lower than the dry bulb temperature, this makes possible a lower condensing temperature and, therefore, a lower discharge pressure and a higher compressor efficiency with an evaporative condenser. Furthermore, intimate contact between the spray and the air in an evaporative con-

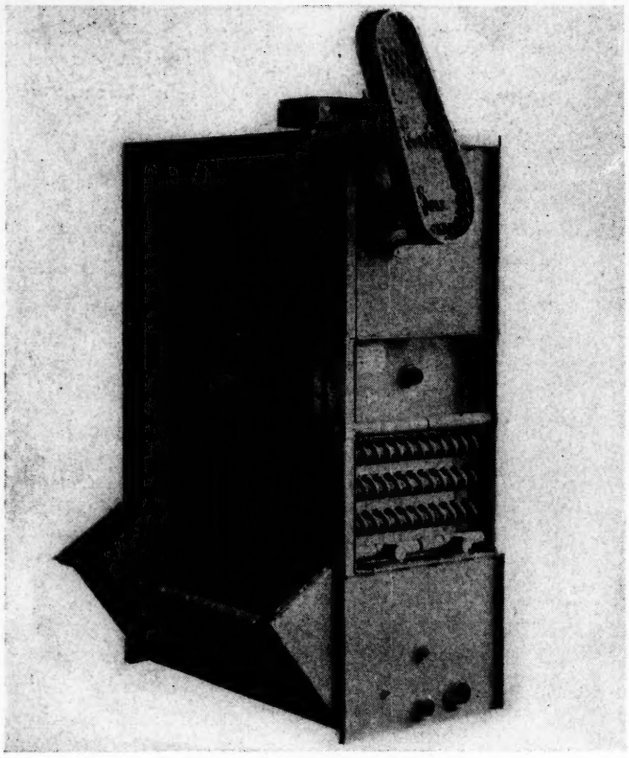


Fig. 3. Typical evaporative condenser.

denser cools the spray to approximately the air-wet bulb temperature. The contact of this cooled water with the fins and tubes picks up heat more readily than air in contact with the fins of the air cooled condenser could possibly do. This is explained by the inherently better rate of heat transfer from metal to water than from metal to air. The air which is in intimate contact with the water film on the fins of the evaporative condenser coil continues to carry away the evaporated water and tends to keep the remaining water film cool. Thus, a smaller condenser coil can be used in an evaporative condenser than can be used in an air cooled condenser.

A smaller fan, and consequently less electrical power, is required for an evaporative condenser than for an air cooled condenser of the same capacity. The evaporative condenser requires about 200 c.f.m. of air per ton of refrigeration while the air cooled condenser requires 800 to 1000 c.f.m. per ton of refrigeration. However, the evaporative condenser requires a water pump and motor large enough to pump about two gallons of water per minute per ton of refrigeration. This pump and the attending operating cost is not necessary, of course, in an air cooled condenser.

To sum up, the first cost for an evaporative condenser is a small percentage greater than for an air cooled condenser, but the operating cost of an evaporative condenser is usually considerably less than for an air cooled condenser.

Installation of Evaporative Condenser

An evaporative condenser, such as shown in Fig. 3, is usually supplied in sections and is intended to be erected on the site of the installation. The sump section is set down first; it may be placed in such a way that the air inlet is facing in the desired direction and the plumbing connections are on the more convenient end. A screen is provided on the air inlet to keep out large pieces of foreign matter such as paper, etc. Another finer meshed screen is applied to the pipe through which the water is drawn from the reservoir by the pump. The air inlet screen may be removed to clean out the sump, to adjust the float valve, or to clean the screen on the pump suction pipe.

The coil section is next erected on top of the sump section. The coil is usually made with two separate refrigerant paths so that it may be operated as one coil or as two coils, depending upon whether one compressor or two compressors are to be attached to the evaporative condenser. The coil section carries the spray header, the spray nozzles, and the eliminator plates.

The fan section is placed finally on top of the coil section and is usually designed so that it can be arranged for front, rear, or top air discharge, whichever is most convenient for the particular installation in question. The location of the evaporative condenser is an important consideration in planning an installation. The condenser may be located in the basement near the compressor and the cooling coil or may be placed outdoors on the ground level or on top of the roof. The outdoor mounting is advisable where basement space is valuable. This location saves the cost of running a duct from the condenser to the outdoors to carry off the humid air.

Embrittlement of Boiler Steel

NEW knowledge regarding the cause of embrittlement of boiler steel has been obtained as the result of a study of intercrystalline cracking in such steel, conducted by the Bureau of Mines. The results are summarized in a paper by W. C. Schroder, A. A. Berk and C. H. Fellows, presented at a recent meeting of the American Water Works Association.

Research work previously conducted by the Bureau of Mines to establish a satisfactory basis for the use of sodium sulfate to prevent embrittlement indicated that existing knowledge concerning intercrystalline cracking was meager and contradictory.

The laboratory results now show that cracking starts from selective corrosion of stressed grain boundaries, usually by sodium hydroxide-sodium silicate solutions. It proceeds through the metal both by selective corrosion and bursting forces exerted on the grain boundaries by the corrosion products that occupy a greater volume than the initial intergranular material.

The laboratory experiments show that lignin and some other organic materials offer more protection than sodium sulfate. They can be used at pressure up to 550 lb. The lignin compounds are now being tested in operating boilers.

ASHVE Opens Summer Meeting With Air Cleaning Session

HOT SPRINGS, VA.—Somewhat handicapped by the weather but with all those attending united in their praises of the beauty of the spot, the American Society of Heating and Ventilating Engineers held its summer meeting at The Homestead here June 20-22.

The technical sessions opened with a paper on "A Test Method for Air Filters" by R. S. Dill of the National Bureau of Standards. Mr. Dill described the apparatus now used for testing air filters at the Bureau of Standards and which involves drawing air through a specimen filter at a predetermined rate, a means of impregnating the air with dust before it reaches the filter under test, and a means of drawing measured air samples of the filtered and unfiltered air simultaneously through filter papers. A photometer compares the densities of the dust deposits on the filter papers. This method gives information on the performance of filters when new but gives no information on the effects of time or use on performance. Consequently, thus far the Bureau of Standards has not investigated filter resistance, such information being held to be of secondary importance compared to the knowledge of the ability of filters to arrest dust.

"The Condensation Nuclei Content of the Air as Related to Air Freshness" was investigated and reported by R. A. Nielson of the Westinghouse research laboratories. According to Mr. Nielson air lacks freshness when industrial and other processes fill it with high concentrations of condensation nuclei. The experiments, however, indicated that the reduction of the nuclei content of air from high city concentrations to low country concentrations adds nothing to its freshness. Consequently, the concentration of these nuclei is not a usable index of the freshness of air in conditioned atmosphere.

A research paper from the University of Minnesota by Professor F. B. Rowley and Richard C. Jordan, on "Air Filter Performance as Affected by Kind of Dust, Rate of Dust Feed and Air Velocity Through Filter" concluded that, for the purpose of rating filters, it would be practical to use heavier dust concentrations than now specified in the Code; that the air velocity at which a filter is tested does not appear to be important, providing it is somewhere between 200 and 400 f.p.m. so that in the authors' opinion there seems to be no reason for changing the 300 f.p.m. velocity specified in the present Code; that lampblack is a very difficult dust to remove from the air and that the 50% of lampblack now used in the standard tests seems to be very much in excess of that found in practice and that this percentage might be reduced in the Code; that the performance of a filter varies greatly with the mixture of dust used and that by proper selection of a test dust, one type of filter may be shown to have better characteristics than other filters, whereas another dust mixture may reverse its relative merits. The authors concluded with the statement of the needs for a further investigation along various lines.

The results of tests on "Heat Transfer Through Single and Double Glazing" made five years ago at the Pittsburgh Testing Laboratory were reported by M. L. Carr, director of the laboratory; R. A. Miller, technical sales engineer, Pittsburgh Plate Glass Company; Leighton Orr, Pittsburgh Plate Glass Co., and Alan C. Byers of the A.S.H.V.E. research laboratory. The authors reported that:

Double glazing reduces heat losses materially as compared with the losses which would take place through the same windows single glazed, under the same conditions of temperature and air movement. The tests made in which only low air velocities were used showed reductions in heat flow ranging from 33 to 46%, depending on the thickness of the air space.

Increasing the spacing between the glass up to ⅜ in. showed a rapid decrease in the rate of heat transfer. A further increase in the spacing produced relatively small change in the heat flow. This fact, together with the dimensional limits of commercial frames, indicates that spacing from ¼ in. to ⅜ in. is the optimum spacing for double glazing. The tests showed about a 40% reduction in heat loss with ¼ in. spacing, as compared with the heat transfer for the same window single glazed and under the same conditions of temperature and air movement.

The few tests made to show the effect of air velocity indicated a very marked effect in increasing heat transfer through windows. This increase was much greater for the single than for the double glazed windows.

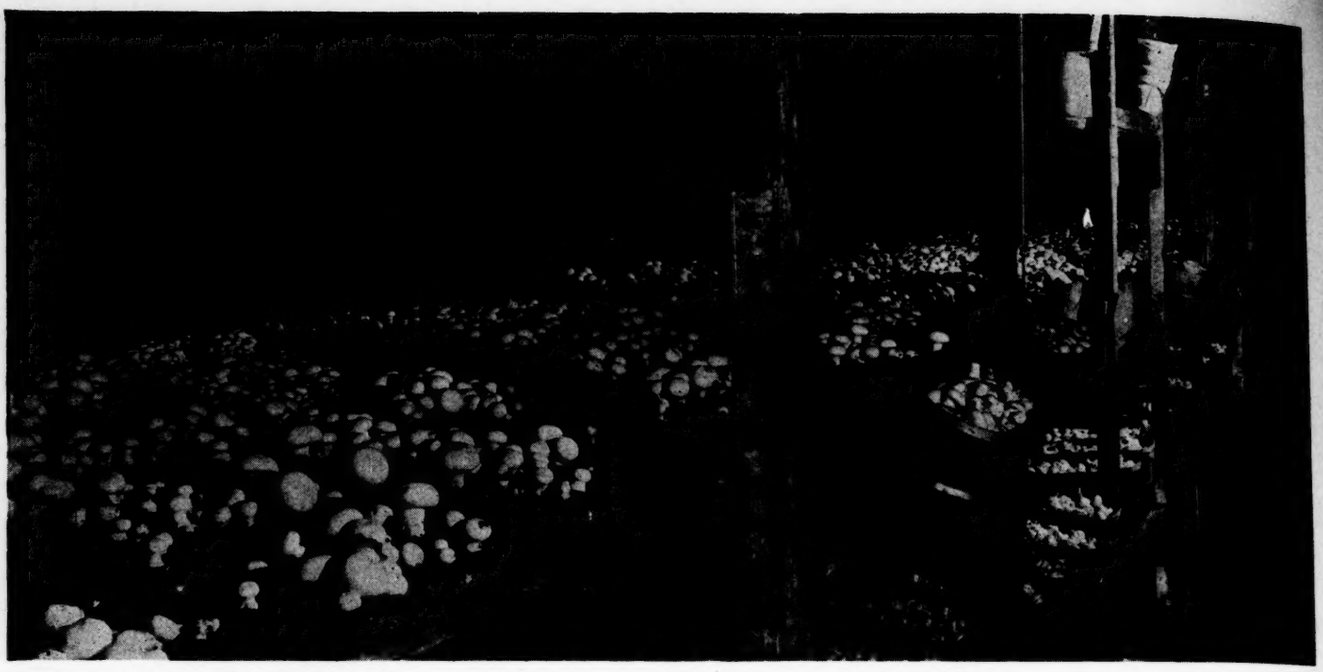
Double glazing results in higher indoor glass surface temperatures, as indicated by the absence of moisture or frost formation, thus resulting in greater comfort for the occupants of the room.

"Radiation and Convection from Surfaces in Various Positions" was the subject of a paper by Gordon B. Wilkes and Carl M. F. Peterson, both of Massachusetts Institute of Technology. The paper, presented by Mr. Peterson, described the results of experiments conducted at M.I.T. with a calorimeter especially built for the tests.

Professors G. L. Tuve and L. J. Siegel, Case School of Applied Science, were the authors of "Performance of Surface-Coil Dehumidifiers for Comfort Air Conditioning," the latest of a series of papers from Case on heat transfer coils. The authors gave seven methods for figuring dehumidifying coils, six of which have been in use before, and the seventh a new method proposed by the authors. This latest method has the advantage that the calculations are very simple, several coil tests are not required for establishing ratings, and trial and error solutions are not required, but with the disadvantage that it is applicable only to specific coils tested and more research is necessary to establish the accuracy of the method.

"A Study of Summer Cooling in the Research Residence Using a Small Capacity Mechanical Condensing Unit" was the title of a paper by Professors A. P. Kratz, S. Konzo, M. K. Fahnestock and E. L. Broderick, all of the University of Illinois. This paper reported the results of tests on cooling the research residence with a mechanical unit having a capacity of 40% less than the one used in previous tests, consequently it was necessary to maintain a somewhat lower indoor dry bulb temperature with a smaller unit in order to maintain the same effective temperature and a rise in the indoor temperature on hot days was allowed when the cooling plant did not have sufficient capacity. The smaller unit was of sufficient size on days when the maximum outdoor temperature was 95F and the minimum outdoor temperature the night before did not exceed 71F; that is, the smaller unit was of sufficient size when the mean daily temperature did not exceed 83F.

Professor F. E. Giesecke and W. H. Badgett of the Agricultural and Mechanical College of Texas, presented a paper on "Seasonal Variations in Effective Temperature Requirements." Professor Giesecke, who is second vice-president of the A.S.H.V.E., was nominated for the office of first vice-president at the convention while J. F. McIntire, present first vice-president, was nominated for president next year. Walter L. Fleisher, at the present time chairman of the research committee, was nominated for second vice-president. Nominations for the Council, to serve three years, are E. K. Campbell, S. H. Downs, and A. J. Offner. The election will be held in January.



Air Conditioning Makes Mushroom-Growing an All-Year Industry

By H. H. MATHER†

IN 1935, W. E. Chambers, vice-president in charge of the Mushroom Division of the Grocery Products Manufacturing Co., West Chester, Pa., undertook the application of air conditioning to the growing of mushrooms. The original installation consisted of one central station plant supplying conditioned air to four houses in the Maple Avenue Plant.

Considerable original application engineering was necessary because of the known fact that any perceptible air velocity on the growing mushrooms would damage them plus the fact that it was essential to maintain uniform conditions at all points in the house. The required temperature and humidity conditions were not known and were determined by intensive research.

Following this experimental installation the effects of air conditioning on the growing of mushrooms was studied for two years. During this period it was proved conclusively that the use of air conditioning was commercially practical. This led to the installation during 1937 of air conditioning in 30 houses in the Greenhill Plant and the canning factory.

The installation in the Greenhill Plant made possible the commercial growing of mushrooms 12 months of the year. The installation of air conditioning in the canning factory assures the product leaving the factory in the peak of condition. Today the mushrooms are grown under controlled air conditions then shipped to the canning factory in refrigerated trucks and stored in a controlled atmosphere until ready for use. They are then sorted and prepared for canning under optimum conditions of temperature and humidity.

How Mushroom Growing Started

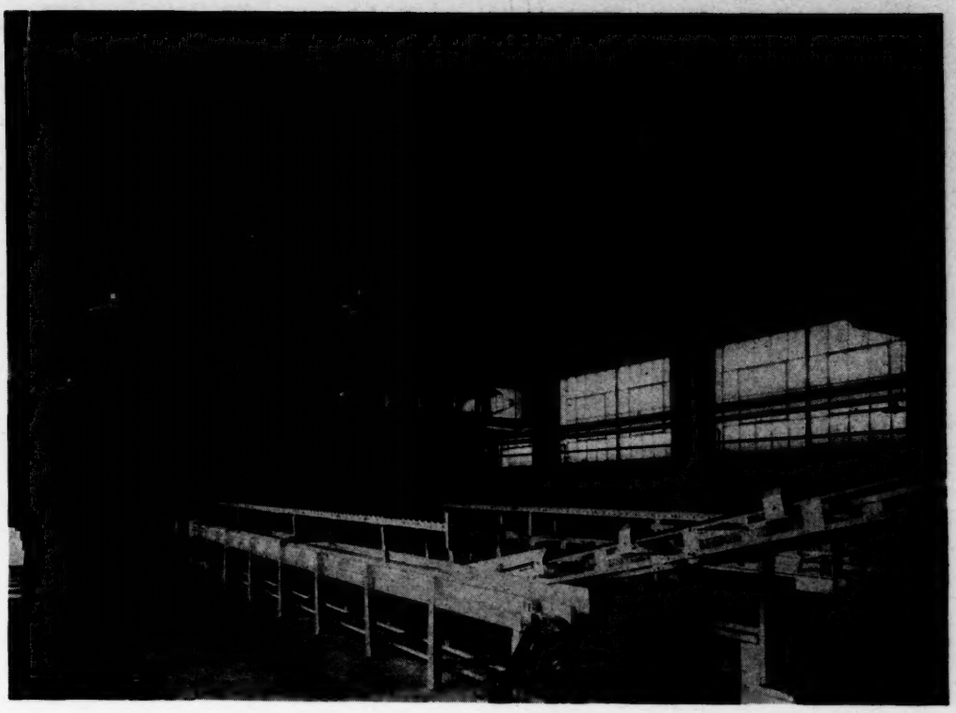
In order to fully appreciate the revolutionary effects of air conditioning in the mushroom industry it is necessary to review the history of the industry and obtain some concept of the growing cycle. Mushrooms have been known as an edible food for hundreds of years. Records show that the first popular acceptance in this country occurred in Philadelphia during the revolutionary period.

At that time mushrooms were very scarce and about all that was known was that they grew in the fields during certain seasons of the year. With the rise in public demand sporadic attempts were made by farmers to cultivate the mushroom. The growing of mushrooms continued as very much a hit or miss business with varying degrees of success until 1904.

In that year Edward H. Jacobs began the first scientific approach to mushroom growing in West Chester. He developed the growing of mushrooms into an exact science and over a period of years established the four growing units in West Chester, which today are known as the Mushroom Division of the Grocery Products Manufacturing Company.

Today the growing of mushrooms has been moved from the fields to concrete, insulated houses constructed without windows. They are grown in tiers of compost

†Industrial Promotion, Philadelphia Electric Company.



Conditioned air keeps the mushrooms under proper conditions from the growing bed until they are canned and ready for the market.

beds that are kept dark throughout the entire growing cycle. This type of house construction is necessary to provide the extreme accuracy of control of temperature and humidity necessary for commercial growing.

The growth and production of mushrooms covers a period of about five months for the complete cycle and falls into four main divisions:

1. preparation of compost, 2. spawning period, 3. mycelium period, 4. picking period.

The preparation of the compost, consisting of horse manure and other ingredients such as leaf mold, is a period of sterilization and chemical reaction. At the proper stage in fermentation this compost is packed in the beds and then pasteurized. Following pasteurization the spawn is planted.

In about three weeks the mycelium has spread throughout the entire bed. The beds are then "cased" which consists of spreading about one inch of top soil over the compost. The beds are watered at regular intervals and in about two weeks the mushrooms begin to appear. This is known as the "first break."

The first mushrooms are full grown in about five days and picking continues until the yield diminishes. The beds are then again watered resulting in the "second break." This procedure is continued until further watering fails to develop additional mushrooms.

The compost is then removed and sold as fertilizer. The boards that make up the beds are thoroughly washed and the houses fumigated. They are then ready to start on another growing cycle.

Proper house temperatures required for each period vary as much as 70F with a temperature of 58 to 60F to be maintained during the mycelium and picking periods.

Because mushrooms require a cool temperature, the 700 growers in southeastern Pennsylvania, where 70% of the domestic mushrooms are grown, have always discontinued operation during the period June to October. This resulted in the compulsory idleness of a tremendous investment during one-third of the year.

The pioneering step by Grocery Products Manufacturing Company was taken in an effort to eliminate this economic waste. The practical value of air conditioning for mushroom growing was indicated during 1937 by the equipping of 30 houses in the Greenhill Plant. The commercial success of this experiment is proven by the fact that plans are now being made to extend air conditioning to the 62 houses in the South Plant.

Air conditioning is revolutionizing the growing industry and has made possible the growing of three mushrooms where two grew before.

Preventing Trouble with Vibrating Air Conditioning Machinery

Vibrating air conditioning machinery often causes trouble due to broken pipe and other connections. In many instances the vibration of the machinery is sufficient to cause crystallization in the metal which results in a fracture at the point of connection.

It has been found that breakages of this kind most commonly occur in connections that are made "too high." The solution that has been found best is to bring the pipe or part to be connected down to a position near the foundation and make the connection there. The explanation is that the amplitude of vibration is always least at the foundation and greatest in the parts of the machine that are most remote from the foundation, precisely as in a tuning fork. Thus for instance the top of an air conditioning refrigeration compressor "moves" farther, as it vibrates, than does the base.

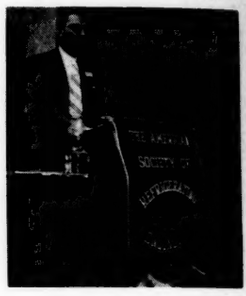
The logical place for connecting pipes, cables, ducts, etc., is therefore as near the point of least vibration motion as practicable—near the foundation. This applies also to flexible types of connectors made specially to resist vibration, whether metallic or non-metallic, because even they have their bending limitations.—*W. F. S., Newark, N. J.*

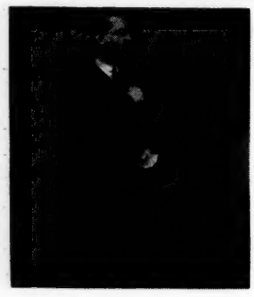
ASRE Meets at Penn State

Approximately 170 members and their guests registered at the 25th summer meeting of the American Society of Refrigerating Engineers held at The Pennsylvania State College, State College, Pa., on June 19 to 21. Headquarters for the meeting was the Nittany Lion Inn, while the sessions were held in the auditorium of the Home Economics Building, shown at the right. Following the convention many members attended the Food Preservation Conference June 21 to 23.

DR. H. C. RENTSCHLER, Director, Research Laboratories, Westinghouse Lamp Division: "The use of ultra-violet radiation from artificial sources has frequently been suggested as a bactericidal agent and for the prevention of mold growth. Definite factors regarding the action of radiation for the killing of bacteria and the prevention of mold growth have been established. For example air borne organisms require much less radiation (only about one-tenth) than is required to kill these same organisms after they have settled on a petri plate or in a liquid medium. This is of special importance in the use of radiation for sterilizing air as in air conditioning."

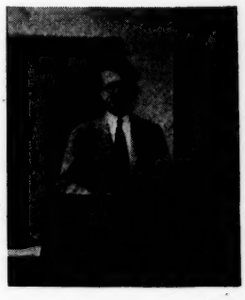
G. L. SIMPSON, Vice President, Pittsburgh Lectrodryer Corporation, Pittsburgh, Pa., presented a paper entitled "Aspects of Adsorption Dehumidification." In his talk he stated that while the ideal adsorbent had not yet been found, many remarkable results have been achieved with present adsorbers. He brought out the fact that adsorbents depend upon a surface action for their moisture removal while materials known as absorbents depend upon a molecular change. Removal of moisture by adsorption has been applied successfully in many fields including optical instrument storage, compressed air systems, and film, cable and drug manufacturing.

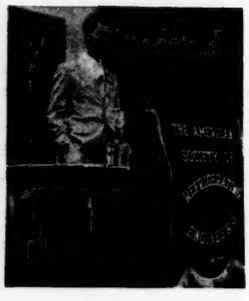




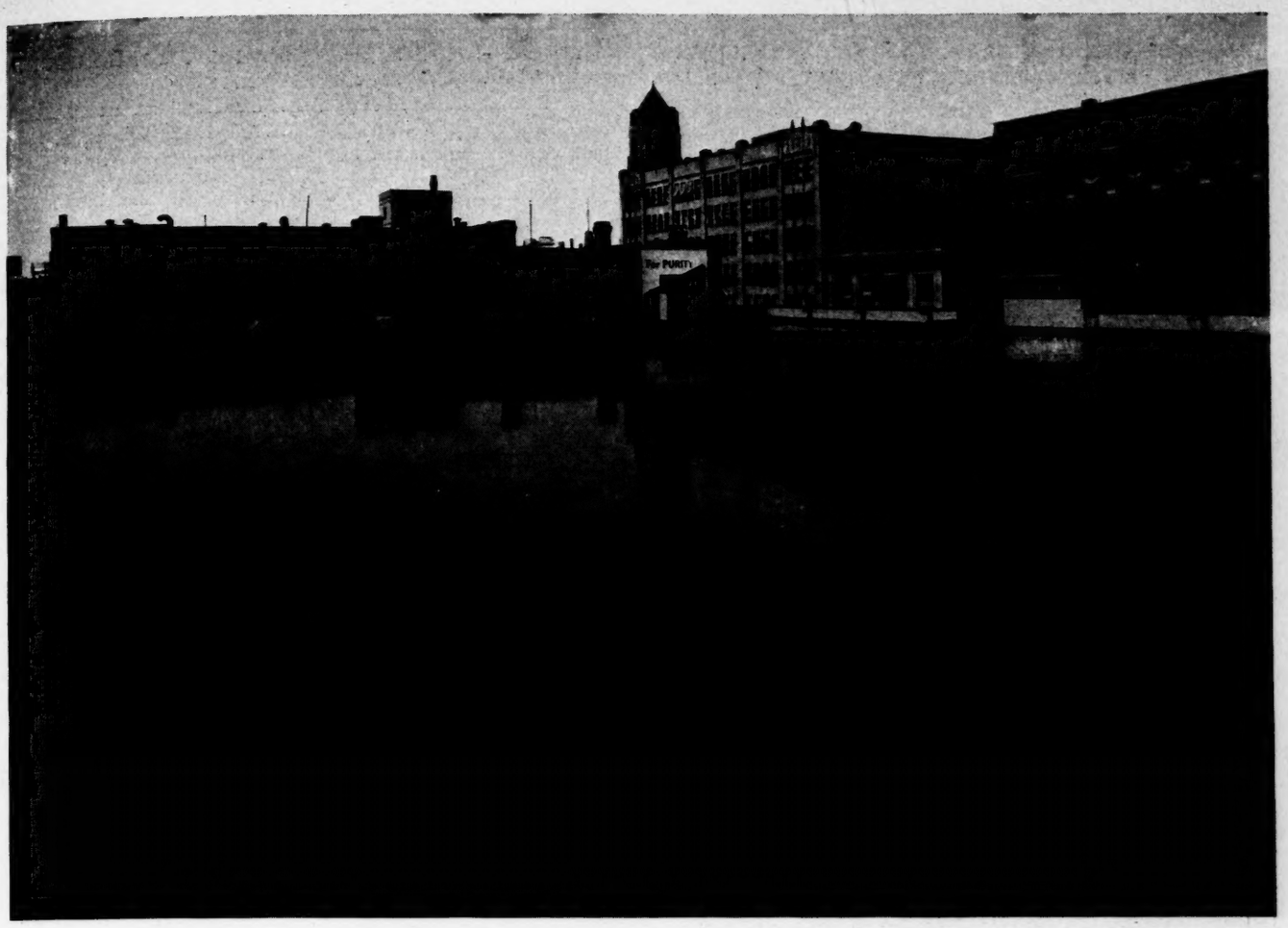
WILLIAM L. KNAUS of the General Electric Company, discussing the ideal refrigerant, said: "It is interesting to speculate on what would happen if a refrigerant were discovered having about the same pressures as Freon, but having a molecular weight of 60 instead of 121. With pressures the same as those of Freon, the displacement rate per ton would be unchanged, so that the new refrigerant would permit, for the same speed, cylinders having nearly three times the capacity of those for Freon. . . . The final conclusion is that an ideal refrigerant would be one having practically all of the properties of Freon except its high density."

L. L. LEWIS, Chief Engineer, Carrier Corp., presented a paper on humidity as a factor in food storage. In respect to the conditions to be maintained he stated: "Normally, a relative humidity ranging from 80 to 88% is accepted as the optimum. The lower limit of this range seems to be fixed by the maximum, which can be carried without causing excessive growth of mold or fungi. . . . 85% can usually be relied upon to prevent excessive growth under the temperatures normally used. The thing to be guarded against is the prevention of dead spots in which the lack of air circulation may permit either excessive air temperatures or relative humidities."





E. W. McGOVERN of the Chlorine Products Division, E. I. duPont de Nemours and Company, Wilmington, Del., told of tests conducted by his company to determine the cause of copper plating in refrigerating compressors. These tests showed that it is the lubricating oils which dissolve some of the copper from the copper parts of the system and carry it to the piston, cylinder bearings and other iron and steel parts. Low refined oils, particularly those which are subject to oxidation, will frequently cause copper plating. However, in order to have this action, it is necessary that other factors such as moisture and high temperatures be present.



A 2-in. roof pool is provided on this air conditioned building to reduce solar heat load. Photos, including cover, in this article courtesy Koppers Co., unless otherwise credited.

A CONSIDERABLE portion of the heat load on an air conditioned building is caused by the radiant heat of the sun. Any means of reducing or eliminating this load will result in not only a smaller initial cost but also a lower operating cost.

Within the past few years many different methods have been tried in an attempt to reduce sun loads on roofs. Some have proved successful while others have resulted in more expense than supplying larger equipment to take care of the original load. It is rather difficult to determine the relative merits of each method since very few tests have been made. However, a few experiments in this country and some more complete ones in England when viewed in the light of actual installations furnish an indication of the reduction in solar heat which may be expected.

Before discussing the various methods in use it may be advantageous to examine just how the sun's energy reaches the roof, what heat loads can be expected, and what factors have an influence on the loads.‡

On most air conditioned buildings the sun load represents an appreciable part of the total peak load on the cooling equipment. Many methods have been tried in attempting to reduce this load and thus reduce the size of the equipment and the cost of operation. In this article the theory of solar radiation is reviewed and the various methods of reducing sun load on roofs are discussed. Some test data are reported and the possible reductions which may be expected are given.

All of the heat from the sun reaches the earth in the form of radiant energy. When this energy strikes an opaque surface, part of it is absorbed and part is reflected back into space. The amount absorbed depends only upon the character of the surface. The darker the color and the rougher the surface the greater the amount absorbed. Some data on actual amounts absorbed are given in Table 1.

This heat which is absorbed raises the surface temperature and thus tends to increase the heat flow through the roof. Because of the intermittent character of the solar radiation and the heat resistance of the roof not all of the heat absorbed by the surface reaches the interior.

Table 2 shows approximately the percentage of heat reaching the interior for roofs of various conductivities.

From this brief examination it can be seen that there are four basic methods which can be employed for reducing the sun heat load. These are: (1) cutting off the sun's rays; (2) increasing the amount reflected; (3) increasing the resistance of the roof; (4) use of water cooling.

The first method, cutting off the sun's rays before they

†Assistant Editor, HEATING & VENTILATING.

‡For a more complete discussion of this subject see HEATING & VENTILATING, April, 1936, pages 37-41, and November, 1932, pages 14-21.

TABLE 1.—DECIMAL PART OF SOLAR RADIATION ABSORBED BY VARIOUS ROOFING MATERIALS.

Asbestos-cement, white	0.42
Asbestos-cement, 6 months' exposure	0.61
Asbestos-cement, 12 months' exposure	0.71
Asbestos-cement, 6 years' exposure, very dirty	0.83
Asbestos-cement, red	0.69
Asphalt, new	0.91
Asphalt, weathered	0.82
Bitumen-covered roofing sheet, brown	0.87
Bitumen-covered roofing sheet, green	c.86
Bituminous felt	0.88
Bituminous felt, with aluminized surface	0.40
Slate, silver grey	0.79
Slate, blue grey	0.87
Slate, greenish grey, rough	0.88
Slate, dark grey, smooth	0.89
Slate, dark grey, rough	0.90
Tile, clay, machine made, red	0.64
Tile, clay, machine made, dark purple	0.81
Tile, clay, hand made, red	0.60
Tile, clay, hand made, reddish brown	0.69
Tile, concrete, uncolored	0.65
Tile, concrete, brown	0.85
Tile, concrete, black	0.91

TABLE 2.—AMOUNT OF SOLAR HEAT TRANSMITTED THROUGH ROOFS

Roof Conductivity, B.t.u. per Sq. Ft. per Deg. F per Hr.	Decimal Part of Absorbed Solar Radiation Transmitted to Inside
0.10	0.02
0.15	0.03
0.20	0.04
0.25	0.05
0.30	0.062
0.35	0.075
0.40	0.085
0.45	0.095
0.50	0.105
0.60	0.13
0.70	0.15

reach the roof surface, is usually not employed because it means the erection of some form of shield. However, in some cases it might prove practical to erect an awning over the roof. In this case the roof would be completely shaded and if the air circulated freely under the awning the roof temperature would be equal to the air temperature. It should be noted that the same effects can be secured from a well ventilated air space between the roof and ceiling, as for example, an attic.

The second method, which attempts to increase the amount of solar radiation reflected by the surface, involves changing the character of the surface. It should be remembered that the ideal treatment would give the roof a pure white and highly polished surface. The closer the treatment approaches this ideal the lower the solar heat load.

It should be pointed out that when this method is employed it is only the character of the surface which affects the amount of heat absorbed and not the materials beneath the surface. For instance, if a black tile roof was coated with a white paint so that the surface was pure white, it would reflect just the same amount of heat as a white tile roof coated with the same paint.

Probably the simplest way of changing the character of the surface is to coat it with a light colored paint—white or as near white as is practicable. This method is usually quite satisfactory in the case of walls or roofs where the surface is brick, stone or wood. Where the roof is of the usual built-up type with a surface of asphalt or pitch, ordinary paint will usually not prove suitable and special paints will have to be employed.

One of the simplest and most effective paints for a bituminous roof is a whitewash made with tallow. Ordinary whitewash would soon wear off so that the following formula whitewash is sometimes used. Quicklime is slaked in a bucket and during slaking tallow is added in the proportion of 5 lb. to 70 lb. of lime. This mixture is then thinned to the consistency necessary for brushing. Two coats will cover most surfaces.

This paint was found to be one of the most effective in reducing the roof temperature. It resulted in roof temperatures actually lower than the maximum air temperature, wore fairly well and was quite waterproof.

Another paint made of zinc oxide in a solution of sodium silicate showed results comparative to the whitewash with an increased durability.

Other finishes such as aluminum and green, red and stone bituminous paints while proving more durable

Water flowing on to a water cooled roof from steel box. A pipe nipple which extends 2 inches above roof level has been threaded into the drain at left.

are not nearly as effective as whitewash. As a matter of fact, tests have shown that aluminum paint reflects only slightly more sunlight than the bituminous paints.

Washes of cement have been tried because of their greater resistance to wear. However, some reports indicated that the surface cracked after short exposure and might have proved harmful to asphalt.

Layers of gravel, particularly those of light color, have been used quite frequently and do result in lowering the roof temperature considerably—in one case reported as much as 27F. This method has the disadvantage of considerable extra weight and inconvenience to walking.

White stone chips pressed into surface gave a light colored, durable coating and temperatures that compared favorably with whitewash.

In many instances, because of the traffic on the roof, none of the above treatments are suitable. In such cases light colored tiles or thin concrete slabs placed over the asphalt or pitch roof will result in a roof which will not only wear well but also will reduce the surface temperatures considerably.

White tiles and concrete slabs give temperatures not quite as low as whitewash but provide a better surface for walking. Concrete slabs because of their thickness also have a high heat lag which helps decrease the amount of heat reaching the interior. Their disadvantages include higher cost and greater weight.

Actual test data on the effect of roof finishes on temperatures for the conditions previously mentioned are given in Table 3.

Insulation

The third method, increasing the resistance of the roof, involves the use of some form of insulation. This method has the advantage of not only reducing the heat load during the summer but also reducing the heat loss during the winter.

The position of the insulation is of much importance not only because of the effect on the heat transmission but also because of the effect on the building construction. The insulation may be placed directly under the waterproofing or made a part of the ceiling. If it is placed under the waterproofing it may result in the waterproofing becoming very hot. On the other hand if made a part of the ceiling it will cause increased expansion of the roof slabs.

It has been pointed out that the presence of insulation in the roof is likely to result in a higher outer surface temperature and consequently increase the amount of heat transmitted over what may normally be expected.

Actual tests have shown that ½-in. wallboard underneath the waterproofing resulted in temperature reductions of 23 ½F; 1-in. cork resulted in 31 ½F reduction; 2-in. cork, 35 ½F, as against a 35F reduction with a whitewash finish alone.

Taking into account the preceding results, it has been recommended that for asphalt or pitch flat roofs not normally walked upon, the construction should include some form of insulation beneath the roof slab and with white stone chips in the waterproofing to protect the surface from the heat.

TABLE 3.—EFFECT OF FINISH ON TEMPERATURES BENEATH ROOF COVERINGS
(Average Sunny Day—Late July or August—Near London, England)

Surface Material	Temperature, F
Sand	110.0
Bituminous paint	
Green	109.5
Red	108.0
Stone color	103.5
Aluminum paint	98.0
Tiling, ⅝ in., red	94.0
Tiling, 1 in., cream	81.5
Spar chips, white	80.5
Cement wash, white	80.0
Tiling, 1 in., white	78.5
Whitewash	75.0

For roofs which will have traffic the construction may be the same except for the substitution of a light colored tile for the stone chips.

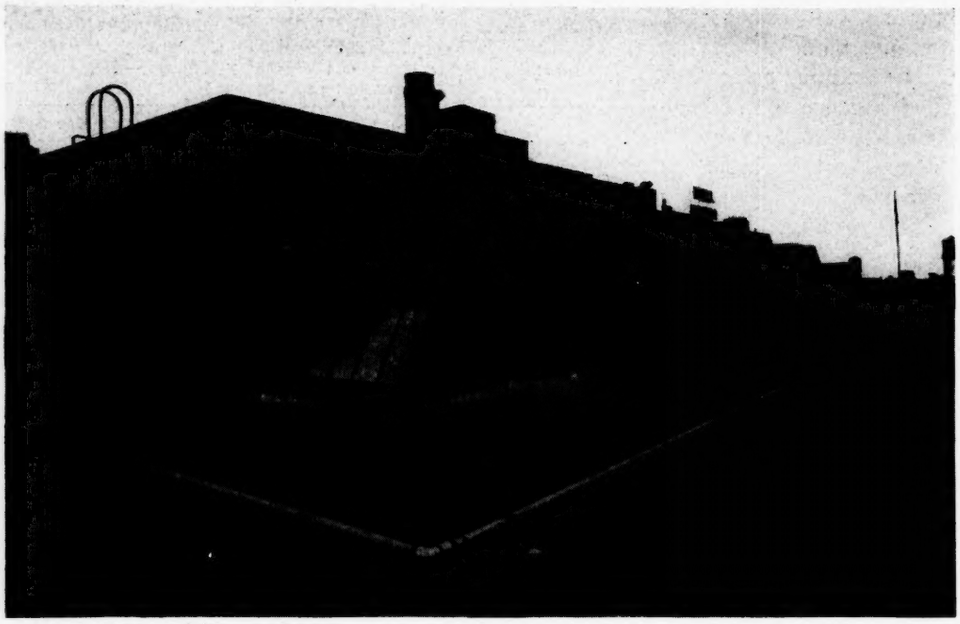
Water Cooling

The fourth general method involves the use of water. The water can either be used as a pool, can be circulated over the roof or sprayed onto the roof.

In the first case where the water is kept on the roof in the form of a pool, use is made of the reflective ability, evaporation, and heat storage ability of the water to reduce the sun load. When this method is used the roof temperature approaches the outside air temperature and it is the practice of some engineers to assume the roof temperature equal to the maximum outside air temperature in calculating the heat gain of the building. It should be remembered, however, that under these conditions the heat conductivity of the roof is greater than shown in heat transmission tables because the outside air surface resistance has been eliminated.

In one test reported by a roofing manufacturer various roofings were applied onto 3-in. thick concrete roof decks and temperature readings were taken 6 in. below the decks. The outside air reached its peak, 93F, at 3 p.m. and it was found that at 4 p.m. the tem-

Spray pond roof used for cooling both water and roof. Louvers prevent wind from carrying spray over the side of the building.



A spray system for roof cooling. Photo taken before spray nozzles were installed but outlets can be seen on mains. Photo courtesy Westerlin and Campbell Co.

peratures 6 in. under the decks covered with the following roofings had reached their maximums:

1. Black top four-ply built-up roofing 103F
2. Slag surfaced four-ply pitch and felt built-up roofing 98F
3. Slag surfaced, four-ply built-up roofing under 2 in. of water 88F

It is possible that the depth of water maintained will have some effect on the amount of heat transmitted through the roof. There is practically no information available which shows how much is heated at various depths by solar radiation, but it is possible that ½ in. of water on a slag roof will have more cooling effect than 2 in. of water. The addition of roofing slag will cause the roof to have a much greater area exposed to the air than it would if not covered and if the slag was kept only partly covered with water, the area above the water level would present a larger surface to the wind and more water probably would be evaporated.

In many cases a constant supply of water is available from wells or the discharge from the condensing unit condensers. Since well water temperatures are practically always lower than the maximum air temperature, the water will not only eliminate the heat from the sun but also lower the roof temperature below the air temperature. Just what the surface temperature would be is difficult to calculate since the water is heated by the sun and air. The actual temperature is somewhere between the air and water inlet temperature but it will vary with the depth of the water, exposure to wind and rate of flow. For calculating purposes the temperature may be assumed at half-way between the air and water temperature.

When condenser water is used the temperature may be either above or below the maximum air temperature. When it is above it will serve to remove only the sun heat, the actual temperature varying with the temperature of the water, depth of water and exposure.

If water is sprayed onto the roof and the rate of spraying is controlled so that most of the water evaporates as it touches the roof, the roof surface temperature will approach the wet bulb temperature of the air. In dry climates, such as southwestern United States, the roof surface temperature may even fall below the indoor temperature and thus act as a refrigerating machine itself. In most sections, however, the most which can be expected is a temperature somewhat below the outside air temperature. This method of cooling should therefore lower the heat load more than any of the other methods. However, it will usually prove more expensive and allowance will have to be made for the cost of pumping the water to the roof spray nozzles and for the initial cost of the equipment.

In many instances the water from the refrigeration condenser is cooled in this manner. In other words, the roof is converted into a spray pond for the air conditioning condensers. This serves two purposes, to cool the water and to reduce the roof heat load.

Whenever roofs are kept wet continually by either sprays or pools it is very important that they be designed for the purpose. Special construction is needed because the water will tend to rot certain types of roofing and also because of the weight of the roof pools.

All built-up roofs are constructed of successive layers of saturated felt and waterproofing. The waterproofing used is either tar or asphalt. Tar or pitch is a byproduct of coal distillation while asphalt is either obtained from oil distillation or from asphalt lakes.

In general, authorities agree that tar or pitch stands up better when kept moist since the continued moisture prevents the heat of the sun from driving out the volatile oils and causing the tar to crack. Asphalt, on the other hand, is said to tend to rot when exposed to continued moisture. Therefore roofs which are to be cooled by water sprays or ponds are usually of tar or pitch.

Practically all built-up roofing manufacturers offer roofs specially designed for water cooling. On such roofs special care is taken with the flashing which joins the roof deck and wall because of extra weight caused by roof pools. A pond 1 in. deep will weigh 5.2 lb. per sq. ft.; one 2 in. deep will weigh 10.4 lb. per sq. in.; 3 in., 15.6 lb.; 4 in., 20.8 lb.; 5 in., 26 lb.; and 6 in., 31.2 lb. This extra weight will tend to bend the roof and unless care is taken it may crack the waterproofing.

The Highlander Apartments, Dallas, Tex.

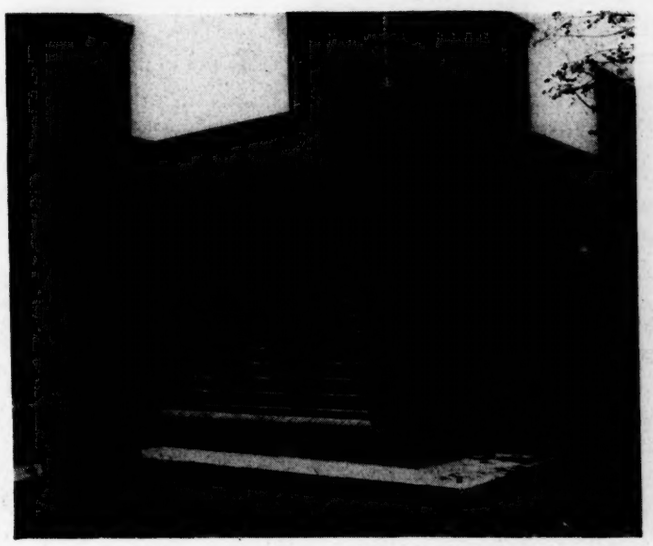
100% Outside Air for Dallas Apartments

INDIVIDUAL treatment to coincide both with the natural problems of the structure and the requests of the owner were necessary in the design and installation of the year-round air conditioning equipment in the $500,000 apartment house at Dallas, Texas, which recently opened its 46 apartments.

The central theme of the demands of the owner was that 100% outdoor air be used for summer cooling after he had made a study of the matter and experienced other types in his office work. He believed that natural conditions in Dallas permit the use of 100% fresh air when this air is passed over a suitable cooling coil kept cold by water circulated over a cooling tower.

It was desired further that the fresh air should be filtered and cooled to produce clean air to conform to recognized health and comfort limitations. The same equipment was to be used for winter heating, with the possible supplementing of spray humidifiers and return air ducts, so that air could be recirculated with sufficient fresh air added to provide ventilation.

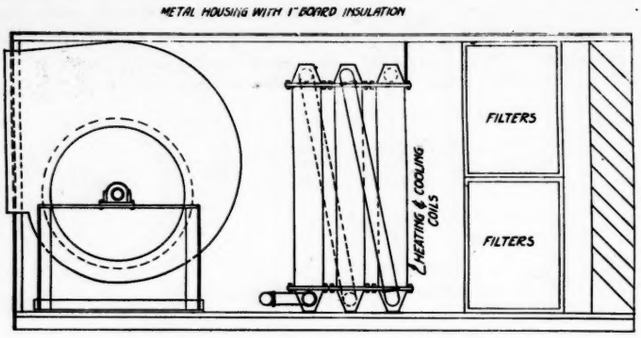
The structure is six stories, of reinforced concrete and tile, with a white stucco exterior. Windows were placed flush with and around the corners, giving every apartment three exposures. Located in North Dallas, it is about three miles from downtown and the apartments are of the three-room and bachelor types.



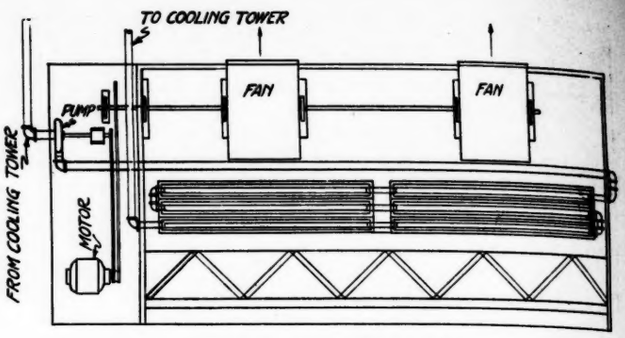
Louvers in The Highlander Apartments in outside air supply.

Early plans included locations and sizes of air duct distributing systems and the use of a 6-in. film of water on the roof, the latter being another owner requirement which was intended to reduce heat gain from the sun. In the course of construction, provision was made for locating the equipment in three general sections with the air ducts concealed.

The cooling and heating equipment is made up of six units installed in multiple banks of two units each. These banks are lo-



Sectional elevation of cooling unit.



Plan view of cooling unit.

cated in equipment rooms, each bank supplying one-third of the building. Two banks are on the ground floor and the third is in the attic. The lower ones serve their halves of the first four floors and the attic bank supplies the two top floors. The units are each capable of supplying 10,000 c.f.m., thus providing a total capacity of 60,000 c.f.m. Three of the units are interconnected for joint use.

Steam is fed to the coils in winter while the cooled water from the cooling towers circulates through them in summer. The warm air delivered from the units in winter is humidified under the control of a humidistat. For summer cooling the units deliver cooled, filtered air, direct from outside the building.

Between seasons the units filter and circulate outside air. Power for operating the units is electric which is furnished by twelve 3-hp. motors, a total of 36 connected horsepower. These motors are arranged with two speeds for the six fans and single speed motors connected to water pumps for circulating the cold water for cooling. The units under outdoor design conditions have a total capacity for cooling equivalent to 28 tons of refrigeration, or a total capacity of 168 tons.

For economy of operation and in order to secure an equitable distribution of air to each of the rooms throughout the building, the fan motors are controlled to change speed. This speed change provides for delivering a predetermined amount of air to the apartment duct systems. The apartment branch duct dampers close or open, according to the requirements of each individual apartment. When the majority of the apartment dampers for a section open, the fan motor operates at high speed; when the majority close, the fan motor drops to low speed.

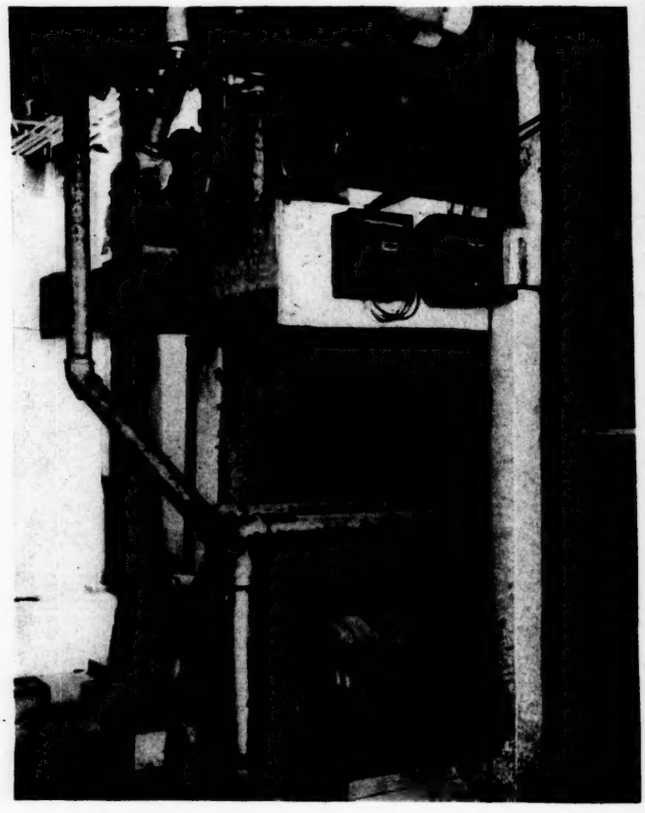
Should the temperature conditions in all the apartments served from any one of the three banks of equipment be such that all the dampers close, the fan motor will stop completely until conditions within one of the apartments cause the damper to open. As the damper opens. the motor starts and operates at low speed until the majority of dampers have opened, whereupon the motor automatically steps up to high speed and operates with maximum output until the majority of dampers again have closed.

To insure a thorough and uniform circulation of air through the rooms and corridors the heating is done with a large volume of comparatively low temperature air. The steam flow into the unit coils is controlled by a modulating type motor valve. This valve is controlled jointly by two temperature controls—one located in the supply duct and the other in the fresh air intake. These thermostats are adjusted to hold the supply air temperature at approximately 110F in mild weather and at a slightly higher temperature in extremely cold weather.

By this method the temperature in the rooms will be kept comparatively uniform from ceiling to floor. The discharge air from the apartments is discharged to the corridors through grilles at the apartment floor levels. This discharge forces the cold air off the floors into the halls, to the return ducts and on back to the heating units. In the summer the return ducts are closed, and the air, after circulating in the apartments, is discharged through the halls and open windows.

It is stated that during the last two seasons this method has been utilized widely in the west and southwest, with numerous installations in Phoenix and other Arizona cities, and in Texas. Apartment houses, tourist cottages and various types of commercial buildings are reported to have been equipped with this method.

Owner of the building is J. E. Earnest; engineer for air conditioning was Edward A. Moyle.



Conditioning unit showing the filters and piping to heat transfer surface fan motor and pump.

Public Water Supplies for Air Conditioning in Cities of 20,000 to 100,000 Population

By O. C. HOLLERAN†

Reliable information on the amount and condition of public water supplies is of the greatest importance to the air conditioning industry not only from the standpoint of the engineer but also from the standpoint of the marketing of the equipment. In this article some of the more important conclusions of a study of the water supply and sewerage facilities in all cities of 20,000 population and over are given. The effect of water supply on the marketing of air conditioning equipment is discussed and detailed information is given on the monthly water temperatures and source of water supply in 242 cities of 20,000 to 100,000 population.

THE continued growth of the air conditioning industry has created many problems affecting other industries. Perhaps the most important of these to the public, and to the air conditioning manufacturing group itself, revolves around the general question of available public water supplies. How important the question of availability may become is well shown in the new study of city water supplies recently issued under the title "Effect of City Water and Sewerage Facilities on Industrial Markets."[1] This report states that in 1936, 388 of the 434 reporting cities of 20,000 population and over had to meet a greater demand than in 1935. The reported increases ran from a fraction of 1% to as much as 50% in individual cities. It is true that many of the cities in this group are known to be among the best markets for air conditioning equipment but it should also be noted that in most cases the water authorities have stated that they are unable to specify what part of the increase is due to any given cause since they keep no record of the purposes for which water is supplied.

Some of these increases, especially in the middle west and southwest, reached amazing figures; as for instance, in Dallas where the 1936 increase over 1935 was almost a billion and a half gallons. That some of these great increases were due to drought and others to greater demand from reviving industries is true, although the lack of detailed records prevents any sound opinion as to the relative position of the three factors —drought, industry, and air conditioning—in creating the greater demand.

The fact that during the past year a continuously greater percentage of new air conditioning installations are using water conserving equipment has naturally reduced the speed of increasing demand for water for operating purposes. Because of this slowing down of new demand, the situation which appeared urgently serious a few months ago has been somewhat eased. The demand for more water continues, however, and eventually will create certain problems which must be solved, if the general public is to receive the full benefits of air conditioning.

In some cities the problem of additional water supply for air conditioning or for any other purpose is already a serious one, as for instance in Amsterdam, N. Y., where 96% of the delivery capacity of the present water works system is already being used, and in Bradford, Pa., where 97½% of capacity is in use. It must not be assumed, however, that the degree of seriousness is common to all cities of the country or indeed to any group of cities regardless of their size or geographical location.

The problem of water supply in large volume either for industrial use or for use in air conditioning plants is eminently an individual problem for each city. The equability of climate, the variation in temperature and humidity, and the temperature of water available are all subject to very large swings both between cities and between parts of the season in a single city, and each has a direct effect upon the water problem of the various cities and, therefore, upon the useful markets for air conditioning and other water-using equipment. Of these factors probably none is more important than the temperature of the water itself.

Normally, water is discharged from the air conditioning plant at a temperature of around 100F. The ability of the water to absorb heat is measured by the difference between the water temperature when entering the plant and at discharge. It follows that the colder the water is when it enters the plant the more heat it will absorb and the less cooling water needed per ton of refrigeration produced. Thus, if water were available only at or above a temperature of 90F it would require the use of large quantities or necessitate installing equipment to permit re-use of the water. On the other hand, if the water has a normal temperature of 60F, it will accomplish the cooling by the use of a comparatively small volume. For that reason, the amount of water used per ton of refrigeration produced will vary tremendously according

†Chief, Industrial Marketing Unit, Marketing Research Div., Bur. of Foreign and Domestic Commerce, Dept. of Commerce, Washington, D.C.

[1]"Effect of City Water and Sewerage Facilities on Industrial Markets." Bureau of Foreign and Domestic Commerce, Washington, D. C. 100 pages; 10 cents.

MONTHLY MEAN TEMPERATURES OF WATER AT MAIN OUTLET IN 242 CITIES OF 20,000 TO 100,000 POPULATION, 1936.

City and State	Source	Temperature of Water at Main Outlet, Deg. F					
		Apr.	May	June	July	Aug.	Sept.
Abilene, Tex.	WS[1]	60.0	65.0	70.0	75.0	80.0	80.0
Alameda, Calif.[2]		55.0	57.0	59.0	62.0	64.0	64.0
Albuquerque, N. Mex.	S	72.0	72.0	72.0	72.0	72.0	72.0
Alexandria, La.	S	84.0	84.0	85.0	86.0	86.0	86.0
Alexandria, Va.	W	50.0	61.0	69.3	73.0	74.0	69.0
Alhambra, Calif.	S	68.0	68.0	68.0	68.0	68.0	68.0
Allentown, Pa.	WS	54.0	58.0	62.0	70.0	69.0	61.0
Alliance, Ohio	WS	45.5	62.6	64.4	68.0	68.0	64.4
Amarillo, Tex.	S	63.0	63.0	63.0	65.0	65.0	65.0
Ambridge, Pa.	S	49.0	51.0	54.0	62.0	65.0	66.0
Amsterdam, N. Y.	W	38.0	39.0	44.0	50.0	57.0	57.0
Anderson, Ind.	WS	54.0	70.0	74.0	86.0	87.0	78.0
Ann Arbor, Mich.	S	53.0	55.0	58.0	62.0	62.5	61.5
Anniston, Ala.	S	63.0	64.0	65.0	66.0	67.0	65.0
Ansonia, Conn.	W	—	—	—	72.0	78.0	—
Appleton, Wis.	W	40.0	60.0	67.0	76.0	72.0	67.0
Asheville, N. C.	W	58.0	68.0	68.0	69.0	74.0	76.0
Ashland, Ky.	W	53.6	62.6	77.0	80.6	82.4	73.4
Atlantic City, N. J.	WS	57.2	59.9	71.6	72.5	68.0	64.4
Attleboro, Mass.	WS	48.3	53.0	59.6	64.3	68.7	67.0
Auburn, N. Y.	W	40.0	47.0	58.0	66.0	69.0	67.0
Augusta, Ga.	W	67.0	76.0	82.0	84.0	85.0	79.0
Aurora, Ill.	S	60.0	60.0	60.0	60.0	60.0	60.0
Austin, Tex.	W	71.0	78.0	84.0	84.0	85.0	79.0
Bangor, Me.	W	40.0	52.0	68.0	69.0	72.0	62.0
Battle Creek, Mich.	WS	50.0	53.0	52.0	51.0	52.0	52.0
Bay City, Mich.	W	44.0	62.0	70.0	78.0	75.0	67.0
Beaumont, Tex.	W	70.0	76.0	88.0	88.0	87.0	87.0
Belleville, Ill.[3,16]		50.0	69.0	80.0	90.0	86.0	83.0
Beloit, Wis.	S	56.0	57.0	57.0	57.0	57.0	57.0
Berkeley, Calif.[2]		55.0	57.0	59.0	62.0	64.0	64.0
Berlin, N. H.	W	39.0	46.0	58.0	66.0	63.0	56.0
Bethlehem, Pa.	WS	51.1	60.9	70.6	74.0	75.0	62.7
Binghamton, N. Y.	W			(34.0 to 74.0)			
Bloomington, Ill.	W	59.0	66.2	69.8	78.8	78.8	68.0
Bluefield, W. Va.	W	50.2	54.2	59.0	65.6	70.6	62.8
Braddock, Pa.	W	51.0	67.0	75.0	78.0	80.0	76.0
Bradford, Pa.[4]	WS	56.0	56.0	57.0	60.0	60.0	56.0
Brockton, Mass.	W	50.0	52.0	53.0	58.0	62.0	62.0
Brookline, Mass.	S	49.0	52.0	57.0	62.0	67.0	66.0
Brownsville, Tex.	W	78.0	81.0	84.0	86.0	87.0	89.0
Burlington, Iowa	W	—	—	—	81.0	87.0	86.0
Burlington, Vt.	W	39.0	47.0	58.0	63.0	66.0	68.0
Butler, Pa.	W	45.0	50.0	55.0	65.0	70.0	70.0
Carbondale, Pa.	W	40.0	51.0	60.0	65.0	70.0	65.0
Cedar Rapids, Iowa	W	50.6	69.7	71.4	82.5	79.2	68.0
Central Falls, R. I.[5]		39.0	62.0	70.0	74.0	74.0	67.0
Champaign, Ill.[6]	S	56.0	57.0	58.0	58.5	56.0	56.0
Charleston, S. C.	W	65.0	74.0	81.0	83.0	85.0	80.0
Charleston, W. Va.[35]	W	52.0	72.0	79.0	83.0	82.0	77.0
Charlotte, N. C.	W	56.0	69.0	76.0	81.0	80.0	77.0
Chester, Pa.	W	50.0	66.0	71.0	78.0	79.0	75.0
Chicago Heights, Ill.	S	55.0	55.0	55.0	55.0	55.0	55.0
Chicopee, Mass.	W	48.2	55.9	61.5	66.4	66.7	62.1
Cicero, Ill.	W	36.0	37.0	39.0	41.0	42.0	41.0
Clarksburg, W. Va.	W	51.0	69.0	75.0	76.0	77.0	72.0
Cleveland Heights, O.[7]	W	39.0	50.0	58.0	68.0	73.5	71.0
Clifton, N. J.[8]	W	44.0	49.0	52.0	55.0	51.0	67.0
Colorado Springs, Col.	W	52.0	54.0	57.0	60.0	62.0	60.0
Columbia, S. C.	W			Averages 75.0			
Columbus, Ga.	W	63.0	71.0	75.0	80.0	80.0	79.5
Concord, N. H.	WS	50.0	58.0	60.0	71.5	73.0	66.0
Council Bluffs, Iowa	W	48.0	62.2	76.0	80.5	81.5	72.7
Covington, Ky.	WS	53.0	68.0	75.0	82.0	81.0	77.0
Cranston, R. I.[9]		48.0	56.0	62.0	64.0	65.0	63.0
Cumberland, Md.	W	55.0	58.0	59.0	62.0	65.0	60.0
Danville, Ill.	W	60.0	68.5	79.5	84.0	83.0	75.0
Davenport, Iowa	W	48.7	67.3	73.2	83.9	82.9	70.2
Dearborn, Mich.[10]		41.0	56.0	64.0	75.0	74.0	68.0
Decatur, Ill.	W	56.5	66.7	75.9	78.6	83.3	73.8
Dubuque, Iowa[11]	S	58.0	58.0	59.0	60.0	60.0	59.0
Duquesne, Pa.	S			56.0 to 68.0			
Durham, N. C.	W	55.9	66.4	72.0	74.7	76.2	74.4
East Cleveland, Ohio[7]		39.0	50.0	58.0	68.0	73.5	71.0
East Providence, R. I.	W	40.0	45.0	50.0	55.0	60.0	60.0
East St. Louis, Ill.[12]	W	50.0	69.0	80.0	90.0	86.0	83.0
Easton, Pa.	W	38.0	45.0	54.0	65.0	65.0	60.0
Eau Claire, Wis.	S	50.0	50.0	50.0	51.0	53.0	62.0
Elgin, Ill.	S	53.0	55.0	57.0	56.0	56.0	54.0
Elkhart, Ind.	S	54.0	55.0	57.0	58.0	60.0	58.0
Elyria, Ohio	S	50.0	58.0	66.0	70.0	72.0	66.0
Evanston, Ill.	W	41.0	49.0	57.0	67.0	72.0	66.0
Everett, Wash.	W	40.0	46.0	54.0	60.0	62.0	50.0
Fargo, N. Dak.	W	41.9	62.6	75.2	85.1	77.9	69.8
Findlay, Ohio[13]	WS	47.1	57.7	63.0	61.7	60.8	59.0
Fond du Lac, Wis.	S	52.0	52.0	54.0	56.0	56.0	54.0
Fort Dodge, Iowa	S	52.0	52.0	52.0	52.0	52.0	52.0
Fort Smith, Ark.	W	60.3	75.0	77.0	75.0	80.0	77.0
Freeport, Ill.	S	56.0	56.0	56.0	56.0	56.0	56.0
Fresno, Calif.	S	72.0	72.0	72.0	72.0	72.0	72.0
Gadsden, Ala.	W	60.0	64.0	76.0	78.0	82.0	80.0
Galesburg, Ill.	S	60.0	65.0	67.0	67.0	67.0	65.0
Glendale, Calif.	WS	68.3	67.9	68.0	68.2	68.2	67.3
Granite City, Ill.[14]		50.0	69.0	80.0	90.0	86.0	83.0
Greenville, S. C.	W	55.0	60.0	70.0	76.0	76.0	71.0
Hagerstown, Md.	W	78.0	80.0	82.0	83.0	82.0	79.0
Hamilton, Ohio	S	62.0	62.0	63.0	65.0	65.0	64.0
Hammond, Ind.	W	50.0	60.0	70.0	78.0	82.0	82.0
Hannibal, Mo.	W	52.0	64.0	78.0	80.0	80.0	75.0
Hazleton, Pa.[15]	W	65.0	65.0	65.0	65.0	65.0	65.0
Highland Park, Mich.	W	41.0	65.0	64.0	73.0	74.0	71.0
High Point, N. C.	W	58.0	66.0	75.0	78.0	—	73.0
Holyoke, Mass.	W	46.0	60.0	69.0	74.0	72.0	68.0
Homestead, Pa.[16]				60.0 to 75.0			
Hutchinson, Kan.	S	60.0	60.0	60.0	60.0	60.0	60.0
Ithaca, N. Y.	W	45.8	54.5	61.1	71.6	70.8	67.5
Jackson, Mich.	S	52.0	52.0	52.0	52.0	52.0	52.0
Jackson, Miss.	W	61.0	73.0	80.0	82.0	74.0	74.0
Jackson, Tenn.	S	66.0	66.0	68.0	68.0	70.0	70.0
Jamestown, N. Y.	S			48.0 year-round			
Janesville, Wis.	S	52.0	52.0	52.0	52.0	52.0	52.0
Jefferson City, Mo.	W	56.0	60.0	65.0	70.0	80.0	76.0
Johnstown, Pa.	W	43.4	48.6	53.5	57.7	59.5	58.7
Kalamazoo, Mich.	S	52.0	52.0	52.0	52.0	52.0	52.0
Kenosha, Wis.	W	45.0	50.0	56.0	59.0	67.0	60.0
Lackawanna, N. Y.[36]	W	—	—	—	75.0	75.0	—
La Crosse, Wis.	S	52.0	52.0	52.0	52.0	52.0	52.0
Lafayette, Ind.	S	53.0	53.0	53.0	53.0	53.0	53.0
Lancaster, Pa.	W	52.0	65.0	70.0	76.0	77.0	72.0
Lansing, Mich.	S	54.0	55.5	57.5	58.0	59.0	59.0
Laredo, Tex.	W	72.2	78.4	84.2	83.3	84.6	78.5
Leominster, Mass.	W	45.0	54.0	65.0	71.0	74.0	64.0
Lima, Ohio	W	49.3	61.5	71.6	74.7	77.4	73.4
Lincoln, Neb.	S	57.0	57.0	58.0	59.0	59.0	59.0
Little Rock, Ark.	WS	66.0	77.0	85.0	88.0	86.0	82.0
Lockport, N. Y.	W	35.0	—	—	—	—	—
Lubbock, Tex.	W	66.0	66.0	67.0	67.0	67.0	66.0
Lynchburg, Va.	W	49.0	54.0	62.0	67.0	73.0	73.0
McKeesport, Pa.	W	50.5	65.2	74.5	78.0	80.6	76.7
Madison, Wis.	S	54.0	54.0	53.0	52.0	52.0	53.0
Manitowoc, Wis.	S	45.0	46.0	48.0	53.0	57.0	58.0
Mansfield, Ohio	S	45.0	45.0	50.0	50.0	50.0	50.0
Marion, Ind.	S	53.0	53.0	54.0	54.0	55.0	55.0
Mason City, Iowa	S	—	—	—	—	59.0	—
Massillon, Ohio	WS	51.0	56.0	55.0	55.0	54.0	55.0
Maywood, Ill.	S	60.0	60.0	60.0	60.0	60.0	60.0
Meridian, Miss.	WS	64.0	78.0	78.0	86.0	86.0	82.0
Michigan City, Ind.	W	42.0	48.0	55.0	64.0	71.0	63.0
Mishawaka, Ind.	S	53.0	53.0	56.0	57.0	57.0	56.0
Moline, Ill.	W	47.0	66.4	74.2	85.9	80.8	72.6
Montgomery, Ala.	S	69.0	69.0	70.0	70.0	71.0	71.0
Mount Vernon, N. Y.	W	43.0	53.0	60.0	64.0	67.0	68.0
Muncie, Ind.	WS	48.7	65.9	70.5	75.5	74.4	68.4
Muskegon, Mich.	W	39.0	46.0	49.0	46.0	68.0	66.0
Muskogee, Okla.	W	60.1	71.8	80.4	87.7	90.7	83.8
Nashua, N. H.	S	40.0	50.0	52.0	58.0	67.0	65.0
New Albany, Ind.	W	51.0	72.0	77.0	83.0	82.0	78.0
Newark, Ohio	W	48.0	62.0	67.0	70.0	70.0	64.0
New Brunswick, N. J.	W	54.0	—	—	71.0	—	—
Newburgh, N. Y.	W	54.0	54.0	54.0	54.0	54.0	54.0
Newport, R. I.	W	43.5	55.6	66.0	70.2	70.2	59.1
Newport News, Va.	WS	58.0	71.0	77.0	82.0	82.0	76.0
Niagara Falls, N. Y.	W	35.6	44.1	59.9	69.8	68.0	66.2
Norristown, Pa.	W	—	—	—	—	84.0	—
No. Little Rock, Ark.[17]	W	79.0	79.0	80.0	82.0	85.0	80.0
No. Tonawanda, N. Y.	W	42.0	54.0	66.0	77.0	78.0	73.0
Norwood, Ohio	S	56.0	56.0	56.0	56.0	56.0	56.0
Oak Park, Ill.	W	52.0	64.0	68.0	70.0	75.0	73.0
Ogden, Utah	WS	55.0	55.0	60.0	60.0	60.0	60.0
Oil City, Pa.	S	42.0	45.0	51.0	57.0	62.0	65.0
Orlando, Fla.	W	77.0	81.0	84.0	86.0	87.0	86.0
Oswego, N. Y.	W	38.0	43.0	49.0	58.0	49.0	55.0
Ottumwa, Iowa[18]	W	62.5	67.5	72.5	77.5	77.5	72.5
Paducah, Ky.	W	69.0	79.0	87.0	89.0	87.0	80.0
Pasadena, Calif.	WS	62.0	65.0	68.0	73.0	74.0	74.0
Passaic, N. J.[8]	W	44.0	49.0	52.0	55.0	51.0	67.0
Pawtucket, R. I.	W	39.0	62.0	70.0	74.0	74.0	67.0
Pensacola, Fla.	S	70.0	70.0	70.0	70.0	70.0	70.0
Perth Amboy, N. J.	S	54.0	54.0	54.0	54.0	54.0	54.0
Petersburg, Va.	W	55.4	71.6	75.4	75.4	78.0	71.6
Pine Bluff, Ark.	S	70.0	70.0	75.0	78.0	80.0	75.0
Pomona, Calif.	S	—	—	67.0	—	—	—
Pontiac, Mich.	S	55.0	55.0	55.0	55.0	55.0	55.0
Portland, Me.	W	40.5	48.0	56.3	64.0	66.0	64.0
Portsmouth, Ohio	W	50.0	68.0	77.0	80.6	78.8	75.2
Poughkeepsie, N. Y.	WS	43.4	59.1	68.9	75.2	76.6	71.3
Pueblo, Colo.	W	53.0	61.0	69.0	74.0	74.0	70.0
Quincy, Ill.	W	46.8	65.8	73.4	82.2	79.9	71.6

MONTHLY MEAN TEMPERATURES OF WATER AT MAIN OUTLET IN 242 CITIES OF 20,000 TO 100,000 POPULATION, 1936 (CONCLUDED)

City and State	Source	Temperature of Water at Main Outlet, Deg. F					
		Apr.	May	June	July	Aug.	Sept.
Quincy, Mass.[19]	W	47.0	57.0	65.0	74.0	73.0	69.0
Racine, Wis.	W	38.7	46.2	54.1	62.8	68.5	62.0
Raleigh, N. C.	W	61.6	73.3	77.0	83.4	81.8	79.0
Richmond, Calif[2]		55.0	57.0	59.0	62.0	64.0	64.0
Riverside, Calif.	S	63.0	68.0	72.0	74.0	74.0	73.0
Rochester, Minn.	S	50.0	50.0	53.0	55.0	58.0	56.0
Rockford, Ill.	S	55.0	55.0	55.0	55.0	55.0	55.0
Rock Island, Ill.	W	—	—	—	—	80.0	—
Rome, Ga.	W	60.0	68.0	77.0	78.0	77.0	72.0
Sacramento, Calif.	W	58.1	62.6	70.7	79.7	80.6	77.0
Saginaw, Mich.	W	44.0	65.0	70.0	78.0	75.0	70.0
St. Cloud, Minn.	W	42.0	52.0	68.0	77.0	70.0	64.0
St. Louis Co., Mo.[20]	W	52.0	72.0	77.0	84.0	82.0	76.0
Salina, Kan.	S	57.0	58.0	58.0	60.0	62.0	62.0
San Angelo, Tex.	W	65.0	70.0	75.0	78.0	80.0	77.0
S. Bernardino, Calif.	WS	67.0 year-round					
Sandusky, Ohio	W	46.4	59.4	64.4	75.2	75.2	66.2
San Jose, Calif.	WS	62.0	67.0	68.0	73.0	73.0	73.0
Santa Ana, Calif.	S	69.0	69.0	69.0	69.0	69.0	69.0
Santa Barbara, Calif.	W	—	—	—	—	70.0	68.0
Savannah, Ga.	S	72.0 year-round					
Schenectady, N. Y.	S	46.0	48.0	51.0	55.0	57.0	59.0
Shamokin, Pa.	W	45.0	48.0	52.0	60.0	62.0	65.0
Sharon, Pa.[27]	W	48.0	65.0	71.0	74.0	73.0	67.0
Shawnee, Okla.	W	45.0	45.0	50.0	55.0	55.0	50.0
Sheboygan, Wis.	W	42.0	48.0	50.0	61.0	65.0	61.0
Shreveport, La.	W	72.0	77.0	88.0	91.0	89.0	84.0
Sioux City, Iowa	S	54.0 average					
Sioux Falls, S. Dak.	S	55.0	55.0	55.0	55.0	55.0	55.0
Spartanburg, S. C.	W	59.0	66.0	72.5	78.8	78.8	75.3
Springfield, Ill.	W	55.4	71.2	76.6	79.9	80.6	76.3
Springfield, Mo.	WS	52.0	66.0	68.0	74.0	76.0	75.0
Stamford, Conn.	W	50.5	62.5	69.0	76.0	67.5	68.5
Steubenville, Ohio	W	56.0	58.0	60.0	63.0	68.0	67.0
Stockton, Calif.	S	70.0	70.0	70.0	70.0	70.0	70.0
Stratford, Conn.[21]		47.0	54.0	61.0	63.0	64.0	64.0
Superior, Wis.	S	39.1	42.2	56.2	61.5	64.4	62.9
Taunton, Mass.	W	48.0	52.0	65.0	70.0	70.0	70.0
Texarkana, Tex.[22]	WS	70.0	72.0	77.0	83.0	86.0	86.0
Topeka, Kan.	WS	54.0	66.0	76.0	84.0	80.0	74.0
Troy, N. Y.	W	38.0	55.0	67.5	70.0	72.5	69.5
Tucson, Ariz.	S	68.0	77.0	80.0	80.0	80.0	80.0
Tuscaloosa, Ala.	W	56.0	59.0	64.0	69.0	70.0	71.0
Uniontown, Pa.	WS	50.0	55.0	65.0	68.0	68.0	65.0
Waco, Tex.	W	63.8	74.8	79.5	83.1	84.6	79.8
Waltham, Mass.	S	55.0	—	—	—	—	—
Warren, Ohio	W	46.6	44.8	73.2	78.6	76.5	71.2
Waterloo, Iowa	S	54.0 year-round					
Watertown, N. Y.	W	43.0	61.0	69.0	72.0	71.0	67.0
Waukegon, Ill.	W	39.7	45.1	54.5	65.6	69.8	64.7
Wausau, Wis.	S	46.0	46.0	50.0	60.0	60.0	50.0
Wauwatosa, Wis.	S	52.0 average					
Westfield, Mass.	W	40.0	46.0	56.0	61.0	63.0	58.0
West Palm Beach, Fla.	W	75.9	80.8	84.2	85.6	86.2	84.9
Weymouth, Mass.	W	49.1	57.2	68.0	73.4	75.2	68.0
Wheeling, W. Va.	W	51.0	68.8	75.8	80.9	75.5	76.4
White Plains, N. Y.[23]	WS	45.0	—	—	—	—	52.0
Wichita Falls, Tex.	W	71.0	80.0	87.0	89.0	90.0	85.0
Wilkinsburg, Pa.	W	50.0	61.0	75.0	79.0	77.0	75.0
Williamsport, Pa.	WS	46.0	61.0	62.0	66.0	65.0	63.0
Wilmington, N. C.	W	66.2	78.8	80.6	86.0	84.2	80.6
Winona, Minn.	S	52.0	52.0	52.0	52.0	52.0	52.0
Woodbridge, N. J.[24]	W	51.8	51.8	51.8	51.8	51.8	51.8
Woonsocket, R. I.	W	60.0	60.0	65.0	72.0	70.0	68.0
Yakima, Wash.	W	48.0	52.0	56.0	61.5	65.0	62.0
Zanesville, Ohio	S	62.0 average					

[1]W indicates water supplied by well; S indicates surface water; WS indicates well and surface water.
[2]Included in report for Oakland, Calif. Water temperatures shown are those submitted by Oakland.
[3]Supplied with water by East St. Louis and Interurban Water Co. Water temperatures are those given for East St. Louis.
[4]The main source of supply comes from impounding reservoirs in mountain streams. Ground water is used in emergencies and when there is a prolonged drought.
[5]Central Falls is supplied with water by Pawtucket. A separate schedule was not submitted by Central Falls.
[6]Report covers the cities of Champaign and Urbana.
[7]Cleveland supplies water through master meters to the cities of Cleveland Heights and East Cleveland.
[8]Clifton, Passaic, and Paterson make up the Passaic Valley Water Commission which also supplies water wholesale to several other cities.
[9]Cranston is supplied with water by the Providence and Pawtucket water systems.
[10]Dearborn is supplied with water by the Detroit water system.
[11]Temperatures shown are taken from water used from artesian wells. Water used from springs is approximately ten degrees cooler.
[12]East St. Louis and Interurban Water Co. supplies water for public and private uses in the cities of East St. Louis, Granite City, Belleville, and Venice; the villages of Madison, Nameoki, National City, Swansea, Brooklyn, Fairmont City, Monsanto, and Washington Park; and various unincorporated communities.
[13]The Blanchard River is used in emergencies.
[14]See East St. Louis.
[15]Report covers Hazleton, West Hazleton, and adjacent territory.
[16]Homestead purchases water from Pittsburgh.
[17]North Little Rock purchases its water supply from Little Rock.
[18]Estimated.
[19]Supplied by Metropolitan District Commission of Massachusetts.
[20]The St. Louis County Water Co. supplies all cities and communities in St. Louis County except Kirkwood, Mo.
[21]Stratford is supplied with water by Bridgeport.
[22]Report covers Texarkana, Tex., and Texarkana, Ark.
[23]White Plains takes 60% of its water supply from the New York City pipe line.
[24]Woodbridge is supplied with water by the Middlesex Water Co.
[25]Charleston is supplied by the West Virginia Water Service Co. which also supplies other cities and unincorporated villages in the territory.
[26]The Western New York Water Co. supplies Lackawanna and the suburban territory of the city of Buffalo.
[27]Sharon is supplied with water by the Shenango Valley Water Co. which also supplies water to Farrell and Wheatland, Pa.; and Masury and Petroleum, Ohio.

to the temperature of the water itself. The volume of water needed will be further qualified by its relation to the normal mean temperature of the air in the city under consideration.

Another angle of the individuality of the water use problem is demonstrable by a comparison between cities. At Amarillo, Tex., water temperatures for the entire six-month summer season run from 63F in April to 65F in September, as against a spread of 70 to 80F in Abilene during the same period. Thus the water at Amarillo can normally rise from 7 to 15F more than can the water at Abilene. Obviously, it would take markedly less water to operate a plant of any given size in Amarillo than it would to operate an identical plant in the other city.

The importance of water temperature to air conditioning is further developed through examination of its gross effect upon demand in relation to water available. As an example, we will take city A and city B. Let us assume that in city A, water consumption is 70% of the delivery capacity of the water works. In city B, consumption is 85% of the water works delivery capacity. In city A the water at main outlet has an average temperature throughout the summer months of 83F while in city B the average temperature at main outlet is only 60F. Assuming that both cities because of climate, population, purchasing power and other ordinary marketing factors are potentially equal as markets, it would appear obvious that city B will be normally a much safer market for exploiting the sales of water-using equipment than will city A. Although the latter city is using a greater

percentage of its potential capacity, the extra 23F of water temperature in its favor will mean a tremendous advantage in reducing the amount of water needed to produce a given tonnage of refrigeration. This would reduce its draft upon the public water supply to an extent which, under most conditions, would more than overcome the difference in reserve delivery capacity available in the two water systems.

Another factor affecting the market for air conditioning equipment grows out of the number of active hours of air conditioning needed during the average season. The air conditioning industry, judging by the articles and releases of engineers and manufacturers, has generally assumed that the air conditioning season in various sections of the country will run from 750 to 1200 hr. of need annually. Checking of the daily temperature records of the Weather Bureau, covering most of the cities covered by the Bureau study previously mentioned, indicates that the use of any such average figures is highly dangerous from a marketing point of view. There are some cities in the country, which, practically speaking, have no annual need for air conditioning equipment. Cities whose actual temperature measurement, day by day over a period of years, shows less than an average of 100 hr. per year when the temperature rises above 70F, and with these hours often concentrated into a two- or three-weeks' period. On the other hand, there is a considerable group of cities whose actual hours of need annually average from 1500 to more than 3000 hr. spread over the whole season and often running 24 hr. a day for weeks on end. Under such extreme variations, the problem of cooling becomes individualistic and is not generally subject to standardization.

Unfortunately, in a great many cases city records do not show the volume of water actually used for air conditioning, commercial and industrial purposes, but only the total delivered for all purposes. The manufacturer in deciding upon the type of product most suited to his city market must of necessity give serious consideration to the general water supply situation in that city; otherwise he may well find his sales handicapped either by lack of water or by water use restrictions of crippling severity. Such manufacturers and marketing groups should also carefully check the sewerage disposal facilities of cities which are or which may become major markets for air conditioning equipment because there are some cities where water supply is adequate but facilities for disposing of waste water form a serious problem. Indianapolis, where use of all water wasting equipment is being limited to certain downtown areas because of lack of sewer capacity is an example of this type of problem.

In the great majority of the 436 cities of 20,000 population and up, the water supply is ample for current needs, but many of them, including Alexandria, La., 90%; Amsterdam, N. Y., 96%; Bradford, Pa., 98%; Gadsden, Ala., 94%; Hartford, Conn., 93%; Jackson, Miss., 96%; Nashua, N. H., 90%; San Jose, Calif., 91%; Schenectady, N. Y., 90%; Springfield, Mass., 95%; Uniontown, Pa., 95%; Utica, N. Y., 91%; and Worcester, Mass., 92%, are within 10% or less of their capacity to deliver, and scores of others including a number of the greater cities are within 25% of their capacity.

Summarizing the situation as it exists, it should be noted that the danger of overdemand for water for air conditioning equipment, which appeared so very serious a year or so ago, has been markedly reduced. This is largely due to the fact that practically all of the air conditioning equipment manufacturers have produced water conserving equipment and are putting considerable stress on selling such equipment in preference to equipment designed for the free use of water.

The whole problem of public water supply may also be expected to grow steadily in importance. With every passing year, our annual increases in population, especially in the already densely peopled sections of the country, the concentration of industry, and the modernization of both industries and residential equipment points to an equally constant increase in water demand in a great many metropolitan cities and in the surrounding areas. The free use of water and unnecessary wastage of water must sooner or later be limited because of limitations on sources of supply.

Right and Wrong Ways of Burning Coke

ALTHOUGH coke is, in many respects, an excellent fuel for hand-fired domestic furnaces, some people encounter trouble when using it, as a result of which coal dealers receive complaints, stated P. Nicholls, Bureau of Mines, U. S. Department of the Interior, in an address recently made before a conference of retail coal dealers of Michigan at the University of Michigan, Ann Arbor. Suggestions were made by Mr. Nicholls regarding methods by which much of the difficulty might be obviated.

Coke is truly smokeless, the firepot can be crammed to its capacity so that, unless the furnace is small for the house, firings need only be made three times a day in the coldest weather, and the fuel bed requires no attention between firings. More kindling is required for coke and the dealer should impress this on his customer and, also, be prepared to supply it. Before changing from coal to coke, the dealer should inspect the furnace to see that it is free from leaks in the ashpit, that the joint at the floor is tight, and that the dampers are in good order; also the furnace and flues should be thoroughly cleaned. Coke requires less draft than coal and the dampers do not have to be opened as wide; the rate of burning should be controlled, as far as possible, by the ashpit damper, but, unless the ashpit is very tight, the dampers in the flue must also be used to restrict the rate of burning. A very hot fire can be obtained with coke and the practice should be avoided of opening the dampers wide to obtain a very hot fire quickly, and then because the house is overheated shutting off the drafts completely; this is an ideal way to make clinkers.

Number of Degree-Days in a Normal Heating Season

The length of the normal heating season, its average temperature, and the design temperature are all of value as design data. From the operating standpoint, another unit is used—a quantitative measure of the season's heating load expressed in one single figure—the number of degree-days. The accompanying map and table give such numbers for a normal heating season.

What the Degree-Day Is

The amount of fuel used in the heating of buildings (maintained at usual comfort temperatures inside) is proportional to the number of degrees the temperature falls below 65F. The number of degree-days per day is thus the difference between 65 and the mean outside temperature when the latter is below 65. If the mean temperature is above 65F, there are no degree-days. When the mean outside temperature is 60F there are (65 — 60) or 5 degree-days that day. Totalling these for the month gives the number of degree-days for that month, and this is a measure of the amount of fuel which is used for the heating of buildings in a given locality for that month. The seasonal total of the monthly totals gives the number of degree-days for the whole heating season.

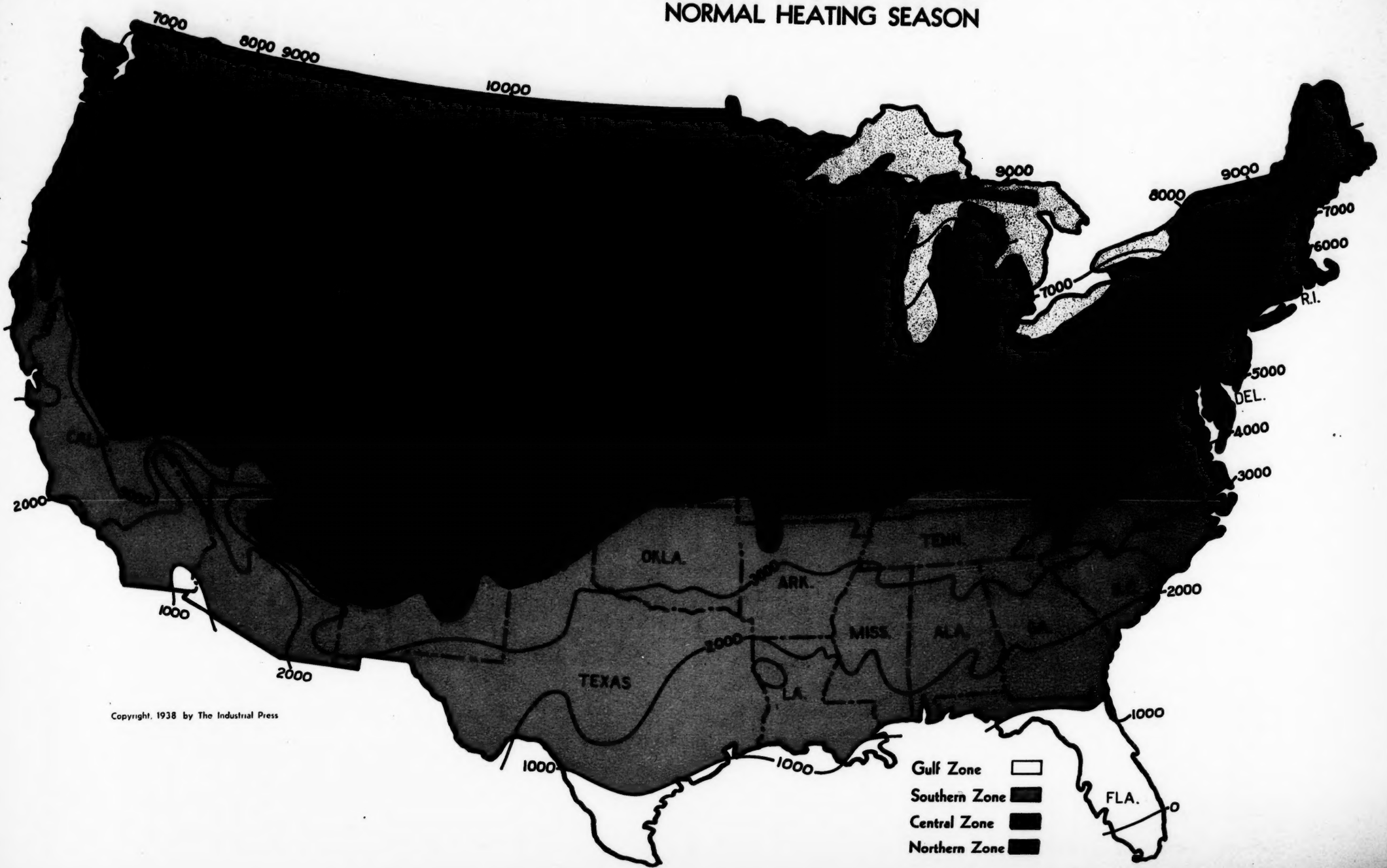
Obviously the number of degree-days varies from city to city and in each city from year to year. The average or normal number of degree-days is the average number of degree-days totaled for all the months of the heating season based on weather bureau records for a long number of years. A comparison of these normal degree-days for a given month for a given city with current monthly figures for that city shows how much fuel should be used currently relative to an average month or year. The figures in the table, and those used in plotting the map, are the normal, or average, numbers for a year.

The exact figure in the average for any city depends on the particular years which are averaged. Figures used by HEATING & VENTILATING are those as averaged for a given city for a period beginning back as far as 50 years. Some organizations independently calculating the averages use records for more recent years which give slightly different figures but which do not differ from others by more than 1%. Since the degree-day cannot be used within a limit of accuracy of 1%, it makes but slight difference which averages are used.

Uses of the Degree-Day

There are two principal uses of degree-day figures. One is in comparing the number of degree-days occurring currently (as reported for a large number of cities each month during the heating season in HEATING & VENTILATING) with those in corresponding periods

NUMBER OF DEGREE-DAYS IN A NORMAL HEATING SEASON



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NUMBER OF DEGREE-DAYS IN A NORMAL HEATING SEASON IN 100 CITIES

City	No. of Degree-Days	City	No. of Degree-Days
Albany, New York	6580	Memphis, Tennessee	2950
Albuquerque, New Mexico	4298	Meridian, Mississippi	2160
Atlanta, Georgia	2890	Milwaukee, Wisconsin	7245
Baltimore, Maryland	4533	Minneapolis, Minnesota	7850
Birmingham, Alabama	2352	Minot, North Dakota	9581
Boise, Idaho	5552	Mobile, Alabama	1471
Boston, Massachusetts	6045	Newark, New Jersey	5383
Buffalo, New York	6822	New Orleans, Louisiana	1024
Burlington, Vermont	7514	New York, New York	5347
Butte, Montana	8272	Norfolk, Virginia	3350
Charleston, South Carolina	1769	Oklahoma City, Oklahoma	3613
Charlotte, North Carolina	3120	Omaha, Nebraska	6131
Cheyenne, Wyoming	7466	Paterson, New Jersey	5365
Chicago, Illinois	6290	Pensacola, Florida	1249
Cincinnati, Ohio	4703	Peoria, Illinois	6109
Cleveland, Ohio	6155	Philadelphia, Pennsylvania	4855
Columbia, South Carolina	2364	Phoenix, Arizona	1405
Columbus, Ohio	5398	Pittsburgh, Pennsylvania	5235
Concord, New Hampshire	7353	Portland, Maine	7012
Dallas, Texas	2256	Portland, Oregon	4469
Denver, Colorado	5874	Providence, Rhode Island	6015
Des Moines, Iowa	6384	Pueblo, Colorado	5514
Detroit, Michigan	6490	Reading, Pennsylvania	5389
Duluth, Minnesota	9480	Reno, Nevada	5892
El Paso, Texas	2428	Richmond, Virginia	3727
Erie, Pennsylvania	6273	Rochester, New York	6732
Eugene, Oregon	4884	St. Louis, Missouri	4585
Evansville, Indiana	4244	Salt Lake City, Utah	5555
Fitchburg, Massachusetts	6632	San Antonio, Texas	1202
Flagstaff, Arizona	7145	San Diego, California	1645
Fort Smith, Arkansas	3213	San Francisco, California	3264
Fort Wayne, Indiana	5925	Savannah, Georgia	1490
Frederick, Maryland	4929	Scranton, Pennsylvania	6129
Grand Forks, North Dakota	9764	Seattle, Washington	4966
Grand Rapids, Michigan	6535	Shreveport, Louisiana	1938
Great Falls, Montana	7228	Sioux City, Iowa	6898
Greensboro, North Carolina	3529	Sioux Falls, South Dakota	7657
Hartford, Connecticut	6036	South Bend, Indiana	6214
Houston, Texas	1157	Spokane, Washington	6355
Huntington, West Virginia	4734	Springfield, Illinois	5373
Indianapolis, Indiana	5298	Syracuse, New York	6893
Jacksonville, Florida	890	Topeka, Kansas	5307
Kansas City, Missouri	4852	Trenton, New Jersey	4933
Knoxville, Tennessee	3670	Tulsa, Oklahoma	3559
Lexington, Kentucky	4618	Vicksburg, Mississippi	1823
Lincoln, Nebraska	5991	Washington, District of Columbia	4626
Little Rock, Arkansas	2811	Wheeling, West Virginia	5218
Los Angeles, California	1504	Wichita, Kansas	4673
Louisville, Kentucky	4190	Wilmington, Delaware	4789
Madison, Wisconsin	7429	Yuma, Arizona	918

for previous years or normally. For example, if a building used 500 tons of coal during a certain season, as compared with an average of 450 tons for the previous season, a comparison of the number of degree-days for the two seasons will show whether the increase is due to severity of weather (degree-days), since the fuel consumed should ordinarily be proportional to the number of degree-days for each period.

The second use of degree-day data is in predicting fuel consumption. For this purpose, normal figures, as given in the table and map, are used in connection with various formulas and constants which have been developed. The prediction can be broken down by months, if desired. (For further information on details of both uses of the degree-day see Degree-Day Handbook.)

Degree-Day Zones

The map shows the number of degree-days expected normally throughout the United States, divided into zones as follows:

Zone	Color	Normal Number of Degree-Days
Gulf	White	Under 1000
Southern	Green	1000 to 4000
Central	Orange	4000 to 7000
Northern	Slate	Over 7000

The Gulf Zone is one where the heating is occasional and buildings more often than not have no central heating. Relatively mild winters prevail in the Southern Zone, just as comparatively severe ones are characteristic of the Northern Zone. The Central Zone, between these two, is a temperate climate and this zone contains the greater part of the population of the country.

200 District Heating Engineers Convene, Elect McCausland

BALTIMORE—The 29th annual convention of the National District Heating Association here June 29, 30 and July 1, attracted a total enrollment of more than 200.

At the closing session J. R. McCausland, Philadelphia Electric Co., was elected president for the coming year; G. D. Winans, The Detroit Edison Co., first vice-president; F. L. Witsell, Toledo Edison Co., second vice-president and J. M. Arthur, Jr., Kansas City Power and Light Co., third vice-president; while Wm. H. Sanford continues as secretary-treasurer.

The opening session June 28 was devoted to the president's address, delivered by T. E. Purcell, The Allegheny County Steam Heating Co.; report of the secretary-treasurer; Landis S. Smith, Rochester Gas & Electric Corp., for the educational committee; and R. M. Nee, Boston Edison Co., for the membership committee.

J. R. McCausland presided at the second session in the afternoon of June 28 which was devoted to reports by the operating statistics committee, by A. D. Leach, Northwestern Electric Co., Portland, Oregon; and of the distribution committee, of which W. A. Herr, Philadelphia Electric Co., is chairman. The report of the distribution committee included studies of the effect of design on the cost of 12-in. high pressure steam lines and manholes when designed in various fashions. J. J. O'Brien, New York Steam Corp., Robert Hall, president of the American District Steam Co., J. J. Schenk, Rochester Gas & Electric Corp., and A. A. Sellke, Detroit Edison Co., each analyzed the subject as applied to a particular form of design. As a part of the report of this same committee A. L. Dutton, Boston Edison Co., reported on manholes and methods of drainage while A. A. Sellke, Detroit, presented a paper on the behavior of insulation and the bowing of piping when steam is admitted to a cold pipe line.

At the third session in the evening of June 28 F. L. Witsell, Toledo Edison Co., presided and A. R. Mumford, New York Steam Corp., presented a report of the steam station engineering committee which included a paper by R. G. Felger, E. M. Brown, and A. S. Griswold, of Detroit Edison Co.; a series of papers on spare capacity in district heating systems, by A. A. Markson, New York Steam Corp., W. A. Herr and G. F. Prestwich, Philadelphia Electric Co., R. C. Hine, Consolidated Gas, Electric Light and Power Co., Baltimore, and E. E. Dubry, Detroit Edison Co. Results of a survey of steel stacks were presented by J. M. Barnes, Philadelphia Electric Co., and George A. Orrok, Jr., Boston Edison Co. Thomas Ravese and T. J. Finnegan, New York Steam Corp., were the authors of a paper on "Tests on Scrubbing of Flue Gases."

At this same session the newly formed Advisory Council under the chairmanship of J. H. Walker, Detroit Edison Co., presented its report which included the recommendation that the Association undertake the publication of a house organ as a publicity and promotion device. Sample copies of the first edition of this proposed house organ prepared under the direction of Harold Coombs of E. B. Badger & Sons, and J. E. Seiter of Rochester Gas & Electric Co., were circulated. As a result of this discussion it was concluded that the sample copies be discussed with executives and that comments and criticisms be returned to the Advisory Council as an aid in forming policy.

With G. D. Winans presiding, the session on June 29 was given over to the commercial relations committee and the sales development committee. Leonard S. Phillips, New York Steam Corp., chairman of the commercial relations committee, presented papers prepared by V. B. Ingram, New York Steam Corp., J. F. Collins, Jr., Allegheny County Steam Heating Co., as well as the suggested text for a proposed bulletin of instructions to users of district steam.

Mr. Ingram's report was entitled "Control Systems, Their Functions, Costs of Installation and Results Obtained." The purpose of this report was to indicate generally methods whereby consideration can be given to the subject of control systems in connection with central station steam, and in his report he tabulated the decrease or increase in steam consumption in 61 jobs after control systems were installed. Only four showed an increase while the savings ranged from 0.5% to 52.3%.

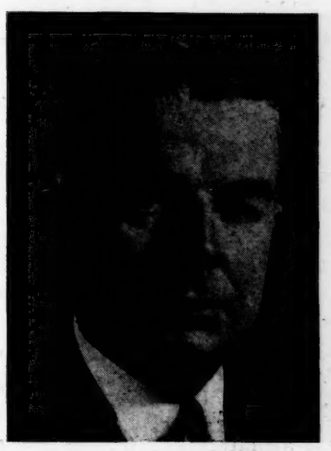
The report stated that when considering the installation of heat control equipment the following factors should be considered.

1. Cost of installation and how it can be paid is important. With one type of control no charge is made for installation nor for the first year's rental. After the first year and each year thereafter, there is a charge of $50 per annum for rental and servicing of equipment.

2. The method of payment. Some manufacturers require payment in full when the installation is complete.

3. Method of operation of heating equipment before the contemplated installation of a control. If a system has been operated very carefully by hand, the percentage of saving probably will not be as great as when a system has not received much attention.

4. Servicing of control equipment.



J. R. McCausland, NDHA's new president.

R. D. Martin, New York Steam Corp., for the sales development committee, presented Henry Obermeyer, assistant vice-president of Consolidated Edison Co. of New York, whose subject was "Advertising." The session on June 30 was occupied by reports from the meters and accessories committee, W. W. Stevenson, Allegheny County Steam Heating Co., chairman; research committee, G. K. Saurwein, Harvard University, chairman; and the chemistry committee, Louis Schnidman, Rochester Gas & Electric Corp., chairman.

In his report of the subcommittee on steam jet refrigeration G. K. Saurwein reported that only three district steam companies have steam jet machines on their lines. He described one of the largest steam jet refrigeration installations in the country, the 840 ton job in the Los Angeles plant of the Firestone Tire and Rubber Co. H. W. Dierman and C. L. Schweizer of the engineering research department, New York Steam Corp., presented information on "Additional Test and Operating Data on Steam Jet Air Conditioning Equipment," while Townsend Tinker of the Ross Heater and Manufacturing Co. had a report on "Steam Jet Coolers with Evaporative Condensers."

At the closing session on July 1 the rates and regulations committee under the chairmanship of J. M. Arthur, Jr., Kansas City Power & Light Co., and the bulletin publication committee with Wm. H. Sanford, as chairman, presented their reports.

Exhibitors at the manufacturers' exhibit included Central Station Steam Co., HEATING & VENTILATING, Spence Engineering Co., Inc., Ehret Magnesia Mfg. Co., E. B. Badger & Sons Co., Warren Webster & Company, Marsh Tritrol Co., H. W. Porter & Co., F. I. Raymond Co., American Radiator Co., American District Steam Co., American Engineering Co., The V. D. Anderson Company, The Babcock & Wilcox Company, Bailey Meter Co., Builders Iron Foundry, S. E. Dockstader, C. A. Dunham Company, The Fulton Sylphon Company, Johnson Service Co., Minneapolis-Honeywell Regulator Company, National Coal Association, Reid Hayden, Inc., The Ric-wiL Company, and Yarnall-Waring Company.

Cyclones and Filters

By JOHN L. ALDEN

AN ordinary cyclone appears in Fig. 64. Dusty air enters the tangential inlet, whirls through several revolutions in the body and cone, depositing its dust load, and departs, still whirling, through the axial cylindrical air outlet. Under the influence of centrifugal force, the dust particles which have been dispersed throughout the entering stream tend to concentrate in the thin layer of air next to the cyclone wall. The downward helical motion of the main air stream and the discharge of a small quantity of air through the dust outlet tend to project the separated solids into the dust bin.

Vortical Flow Through Cyclone

Two distinct vortices are present in a cyclone. One is the large-diameter descending helical current in the body and cone and the other an ascending helix of smaller diameter which extends upward from the region of the dust outlet, through the inner cylinder, to the atmosphere. As soon as the lower end of the inner cylinder is reached, the inner layers of the larger vortical current detach themselves in an effort to escape into the low pressure region along the cyclone axis. Separation of more and more of the air from the outer vortical stream occurs as the latter approaches the apex of the cone until, finally, all of the descending current has joined the rising inner vortex. If the downward air flow has been smooth and unbroken, the dust which is now coasting spirally downward will pass out of the dust outlet without reentrainment.

The engineer who, with goggles, respirator and flashlight climbs into a cyclone to observe its operation will acquire a grasp of centrifugal separation which is difficult to obtain otherwise. Vortical motion will take on a new and impressive meaning and the cyclone will no longer be a bin-like structure in which some vague process of separation takes place.

Factors Affecting Separation

Separation is best when the cyclone diameter is small, the inlet velocity high, the radial thickness of the air stream a minimum and the number of convolutions of the vortices relatively great. The centrifugal force of separation is proportional to the square of the velocity and inversely proportional to the radius of rotation. Resistance to separation is a function of the radial distance the dust particle must travel to reach the cyclone wall, its gravitational settling rate in still air and the length of time it is acted upon by centrifugal separating forces. The time of exposure to these forces is a matter of rotational speed and the number of convolutions of the dust path from the inlet to dust outlet.

Separation Coefficient of Cyclones

The centrifugal force acting on a particle is

$$F = \frac{wv^2}{gr}$$

where

w = weight of particle, lb.,
v = tangential velocity, ft. per sec.,
g = gravitational acceleration, ft. per sec.^{2}
r = radius of rotation, ft.

Since the weight, w, is the force of gravity acting on the particle, the separating effect of a centrifugal cleaner as compared to gravity separation is

$$S = \frac{v^2}{gr}$$

where S may be termed the "separation coefficient." The separation coefficient of a gravity chamber is, of course, 1.0. The separation coefficient has been plotted in Fig. 65 for various diameters of rotation and the more common tangential velocities.

Angular Travel During Separation

The angular distance through which a particle must travel during its radial movement across the entraining air stream is indicated in Fig. 66. A heavy particle entering the cyclone at a is shown to reach the wall of the cyclone at b with comparatively small angular movement. A lighter particle entering at the same place must travel through a much greater angle to reach the wall at c. The smaller the particle size, the greater must be the angle of rotation. Consequently, the greater the number of convolutions of the separating vortex, the smaller will be the particles which can be separated effectively. This is the reasoning which has developed the small diameter, long bodied or long cone cyclones used in flour mills and elsewhere for the collection of finely divided or light dusts.

Field of Application of Large Diameter Cyclone

In this category falls the common cyclone whose body diameter is from 3½ to 6 times the diameter of the inlet pipe. It is useful in situations where large air handling capacity is required and where moderate separating efficiency is adequate. It handles a larger volume of air per dollar of first cost than any other cleaning device. Hence, its applications include the separation of wood wastes, grinding and buffing dusts, textile fibers, and similar materials whose particle size is not less than 50 microns or about 300 mesh. It is not suitable for flour, cosmetic powders, ground pig-

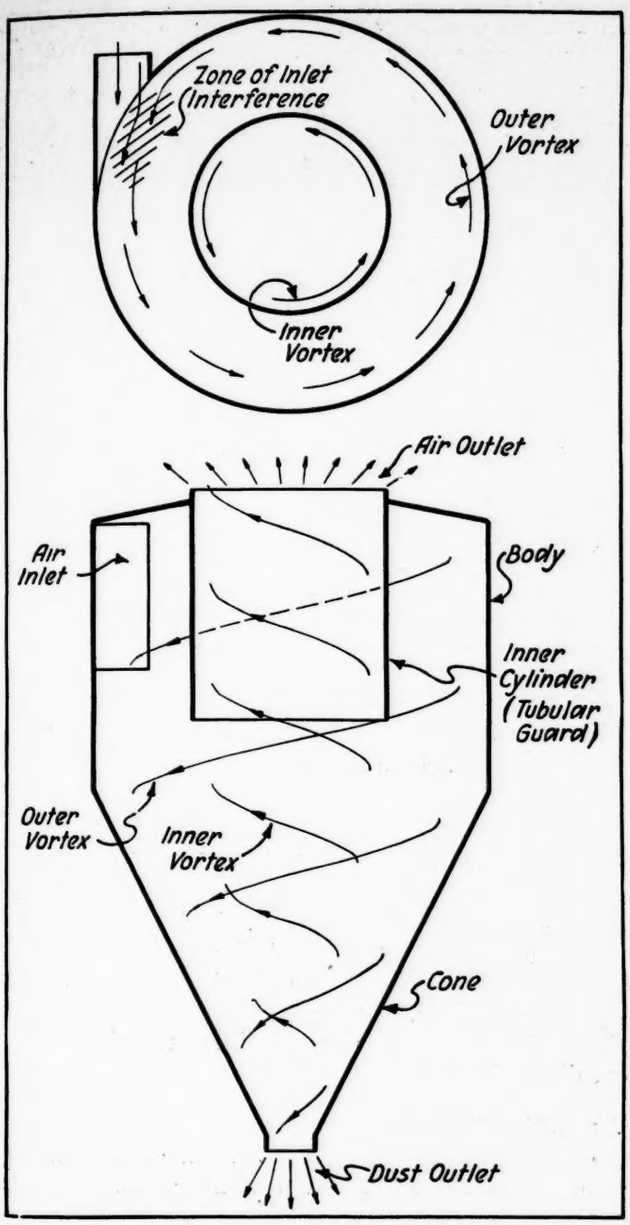


Fig. 64. Common cyclone.

ments, talc and similar finely divided products. Nor should it be used as the sole separating agent for lead dust, arsenic and other poisonous dusts. High concentrations of siliceous dusts such as originate in sand blast systems, foundry shake-outs, tumbling mills and granite sheds impose a cleaning load beyond the capabilities of the common large-bodied cyclone.

Pressure Drop Through Cyclones

The resistance of the cyclone is often the largest single element in the resistance of the entire system. Systems have been tested in which the cyclone furnished 80% of the entire resistance against which the fan operated. Hence, it is regrettable that the literature usually dismisses the subject with such casual statements as "the resistance of a well-designed cyclone should not exceed 1.0 velocity head in the inlet pipe." The reader is left with the problem of recognizing a "well-designed cyclone" and of reconciling actual measurements of resistance ranging from 0.25 velocity heads to 6 or 7 velocity heads.

All of the formulas for cyclone resistance may be resolved to the form

$$h = C\,h_v$$

where

h_v = velocity pressure in cyclone inlet pipe,
C = constant.

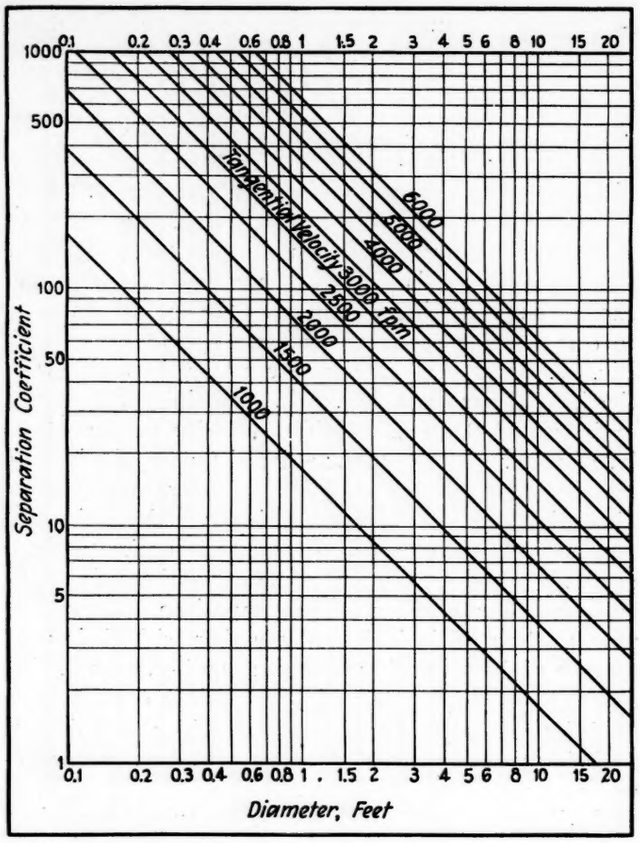
Table 18 lists several published values for C. It is evident that not all of them can be right. Furthermore, their extraordinary disagreement casts discredit upon the entire list. To illustrate in a practical way the shortcomings of these formulas, they have been used to compute the resistances of two cyclones shown in Fig. 67. These are identical except for the addition of the inlet deflector in Fig. 67b. The inlet velocity of each was 6430 f.p.m., the inlet velocity pressure 2.59 in. of water and the measured resistances of Fig. 67a and b were 5.10 and 2.92 in. of water, respectively. Since the inlet velocities were identical, the resistance formulas assign equal pressure drops to the two cyclones. The extent to which these expressions give misleading results is shown in the comparison of computed values tabulated in Table 18 together with their percentage of departure from the measured resistance. Except for space limitations, the comparison could be extended to many other cyclones for which records are available with no closer agreement between calculated and measured pressure drops.

Having thus disposed of existing formulas, the author must confess that he has no alternative expression to offer. The laws of cyclone resistance have not been developed on a general basis. Moreover, the cyclone as installed is so often adjusted, "corrected," and tinkered with by the erecting mechanics, often to compensate for troubles originating outside the cyclone, that cyclones of identical dimensions applied to similar conditions have been found to impose widely varying resistances. For example, a number of cases are known wherein the resistance of one cyclone is as much as 3½ times that of another installed in the same plant and engineered by the same firm.

Low-Loss Cyclones

While we have too few data to predict cyclone back pressure in general terms, two types of cyclone can be described which definitely eliminate the major avoidable loss. Referring again to Fig. 64, it will be observed that the entering stream is deflected and partially shut off by the impingement of the whirling stream that has completed one revolution within the cyclone body. The impact of the whirling mass on the inlet stream introduces resistance to entry in much the same way as do two streams uniting in a breeching or tee. The remedy is the same as that for breeching losses—to bring both streams parallel before they join. Thus, in Fig. 68, the roof of the cyclone is helical in shape so that at the completion of the first convolution the whirling stream is parallel to and below the entering flow. The second device, Fig. 69, is the separating diaphragm or deflector which compels parallelism of the currents before union. Both designs are known to reduce the pressure loss to not more than 50% of that of a plain cyclone of equal dimensions.

A third design, shown in Fig. 70, is capable of effective separation without excessive pressure drop. The



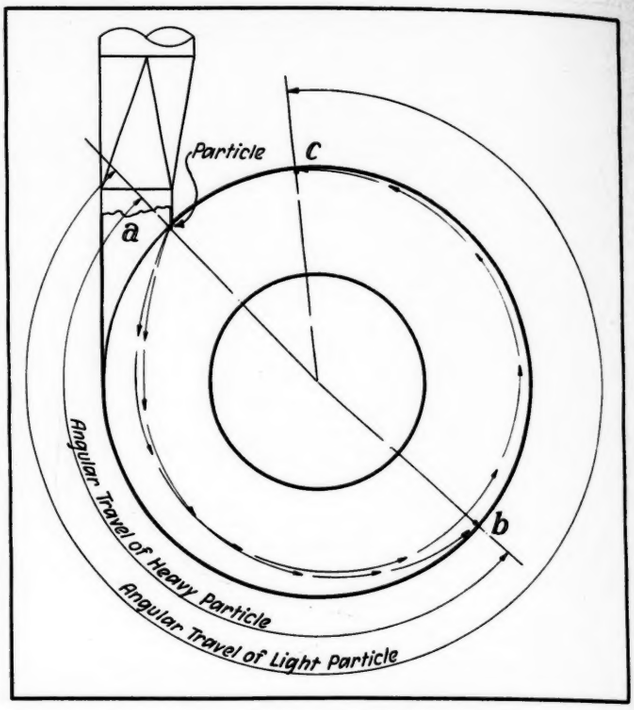


Fig. 65 (Left). Separation coefficient of centrifugal separation. Fig. 66 (Above). Angular travel of dust particle during centrifugal separation.

essential feature is the series of scoops or vanes which deflect into the air outlet some of the spinning mass of air at the lower end of the inner cylinder. The proportions of the collector body and the size and location of the scoops are somewhat critical if the local eddies formed by the scoops are not to reentrain dust already thrown out by centrifugal force. This design, also, is capable of reducing the pressure loss by at least one-half.

Table 19 gives the dimensions and capacities of helical-top cyclones whose back pressures will usually be less than 0.6 velocity head. The dimensional symbols refer to Fig. 68.

Fig. 67 (Below). Two cyclones whose resistances are calculated by formulas in Table 18. Fig. 68 (Right). Low resistance cyclone with helical roof.

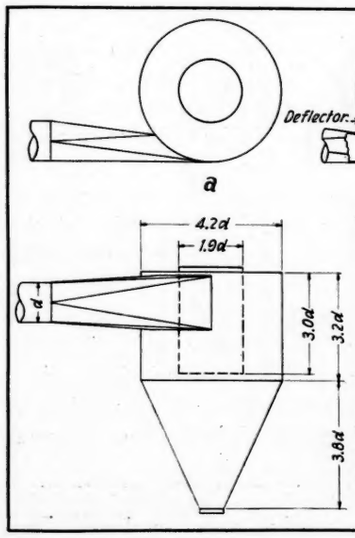


Table 18 - Comparison of Measured and Calculated Resistances of Cyclones

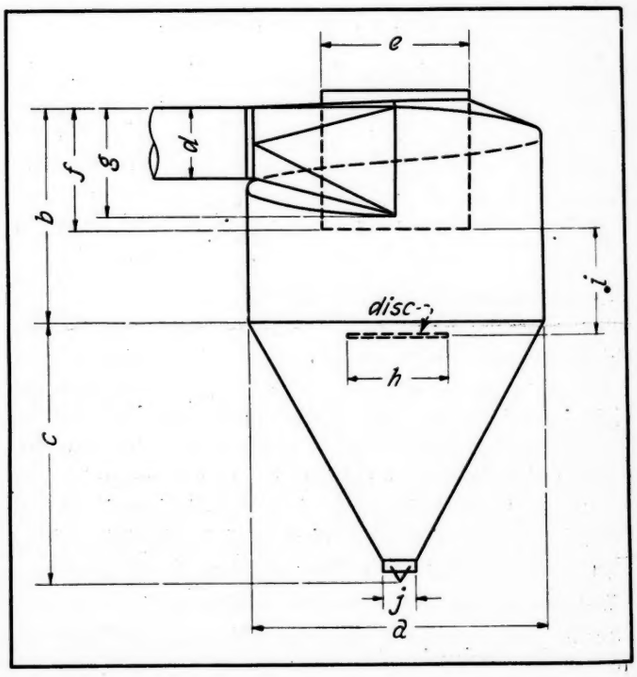
$H = Ch_v$, for 6430 fpm, h_v = 2.59" H_2O		% Error	
		Fig. 67a H = 5.10" H_2O = 1.97 h_v	Fig 67b H = 2.92" H_2O = 1.13 h_v
C	H, in H_2O		
0.21	0.54	-89	-82
1.00	2.59	-49	-11
1.04	2.69	-47	- 8
1.61	4.17	-18	+43
2.09	5.41	+ 6	+85
2.33	6.04	+18	+107
3.22	8.34	+63	+186
3.88	10.04	+97	+244
6.44	16.67	+227	+471

Cyclone Shapes

The buyer can afford to be skeptical of the claims advanced for large diameter cyclones whose chief distinction is novelty of appearance. Aside from the low-loss features just described, variation from conventional proportions adds little to the cleaning efficiency or to operating economy. During the past 50 years innumerable varieties have been marketed, most of them without distinctive merit.

Tangential Cyclones

A coneless centrifugal separator can be constructed in the manner shown in Fig. 71. In this cyclone sepa-



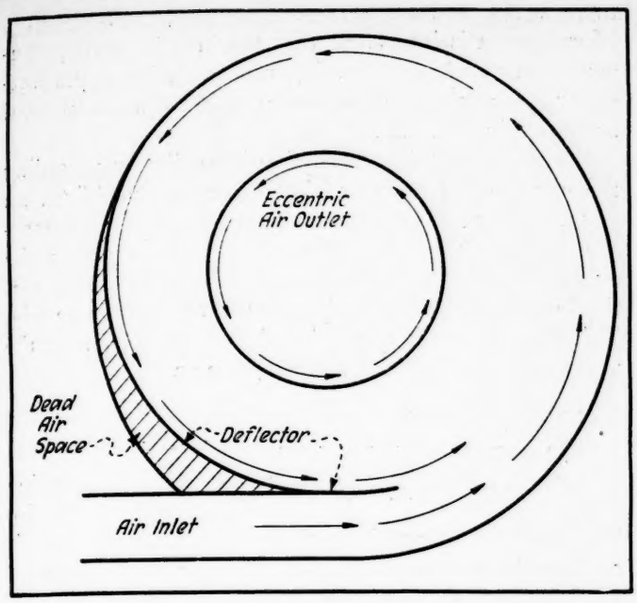


Fig. 69. Low resistance cyclone with inlet deflector.

ration is accomplished by skimming off the dust-bearing outer layer of air. Inlet and dust outlet are tangential while the two air outlets are axial. The body is approximately involute in profile so as to avoid inlet interference. This factor, jointly with the double air outlet of large size, contributes to low resistance. The loss can be held at 0.2 to 0.3 velocity heads.

The angular distance between the air inlet and dust outlet seldom exceeds 300°. Therefore the minimum particle size is limited. Nevertheless, the separation compares favorably with that of the ordinary cyclone when the maximum radius of curvature of the involute does not exceed 3 ft. This corresponds to a capacity of about 5000 c.f.m.

The addition of reversed vanes in the air outlet, forming in effect a louvered inner cylinder, increases the cleaning efficiency in the range of small particle size. When skimming from 10% to 15% of the total air, efficiencies as high as 95% are reported for particles larger than 35 microns[1]. The addition of the outlet vanes increases the resistance to a level of 1.0 to 2.0 velocity heads. A tangential cyclone with outlet louvers is shown in Fig. 72.

Another tangential separator consists of a closed drum with tangential air inlet and outlet. An internal helical partition guides the air through several convolutions. A tangential dust skimmer, positioned near the cleaned air outlet, shaves off a thin layer of dust-bearing air. Its separating efficiency is about the same as that of a cyclone of equal diameter. The resistance is about 0.5 velocity head. It has been used effectively as a primary separator and as a centrifugal trap.

Small Diameter Cyclones

Typical small diameter cyclones are pictured in Fig. 73. Because of the small diameter and relatively great

[1]"A Modern Dust Collector," by Herman Van Tongeren, Mechanical Engineering, December, 1935, pp. 753-759.

TABLE 19.—DIMENSIONS OF HELICAL-TOP CYCLONES

Capacity, C.F.M.	Inches									
	a	b	c	d[1]	e	f	g	h	i[2]	j[3]
500..	37	15	33	5	10	12	8	7	8	3
1000..	44	21	40	7	14	16	11	10	11	5
2000..	54	30	49	10	20	19	15	14	15	6
3000..	63	36	57	12	25	22	18	18	19	7
5000..	75	48	68	16	32	28	24	22	24	10
7500..	87	60	78	20	39	34	30	27	30	10
10,000..	97	68	87	23	45	38	34	32	34	12
12,500..	105	75	95	25	50	42	38	35	38	12
15,000..	114	82	103	27	55	45	41	38	42	12
20,000..	127	94	114	32	63	51	47	44	48	13
25,000..	139	105	125	35	70	57	53	49	54	13
30,000..	151	116	136	39	77	62	58	54	59	14
35,000..	163	126	147	42	84	67	63	59	64	14
40,000..	173	135	156	45	90	72	68	63	69	15

[1]Nominal inlet pipe diameter.
[2]Adjustable.
[3]Optional—May be reduced if connected to relief fan.

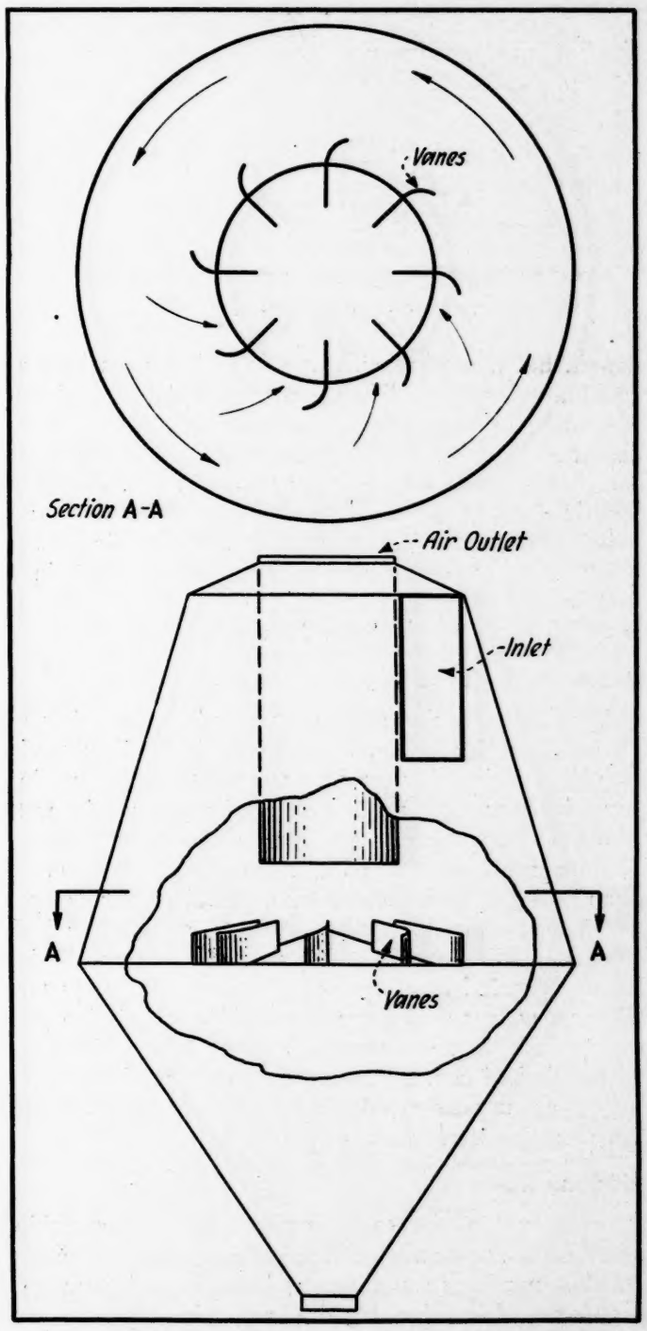


Fig. 70. Low resistance cyclone with scoops or vanes.

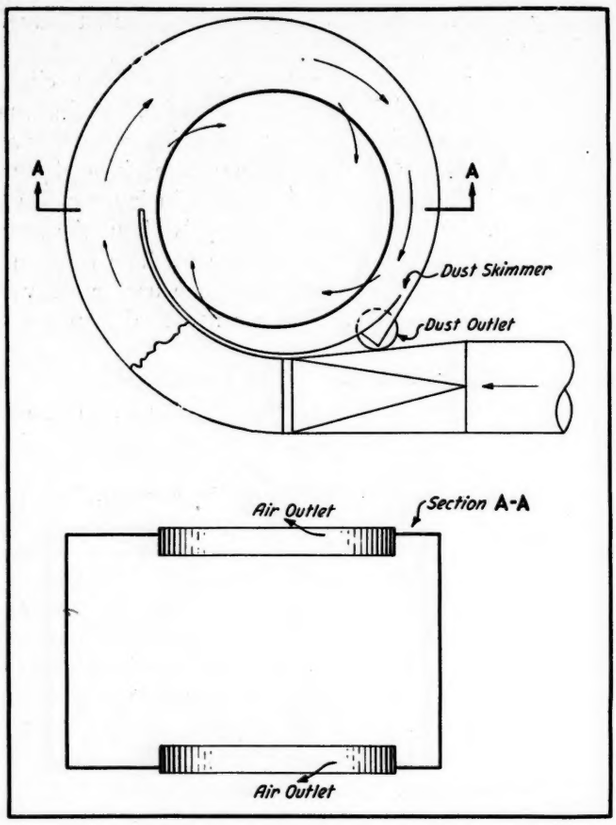


Fig. 71. Tangential cyclone.

length the separating efficiency is high for particles as small as 30 microns. They seldom exceed 4 ft. in diameter and, in consequence, are limited in air-handling capacity. For greater air loads than a single cyclone can handle, they are used in pairs as in Fig. 74a or in multiple as in Fig. 74b. A suction connection at the air outlet is sometimes added as shown in Fig. 74c for the purpose of capturing a portion of the fine dust entrained by the inner vortex. The resistance of small diameter cyclones sometimes exceeds 2.0 velocity heads.

Miniature Cyclone

Very high cleaning efficiencies may be obtained from cyclones similar to Fig. 73 when the body diameter is less than 12 in. For maximum separation, the interior must be accurately made and fitted and must be well polished. All surface roughness and eddy-forming projections must be eliminated. An efficiency of more than 99% has been claimed for a 4 in. diameter cyclone when separating dust whose average particle size is 5 microns. The capacity of such a cyclone would be about 70 c.f.m. at a pressure drop of 2 in. of water. The capacities of larger units of identical design are proportional to the squares of the diameters. Because of the limited capacity of a single unit, miniature collectors are usually installed in clusters of from 4 to 20 fed from the same pipe.

Cyclone Inlets

Air should be fed to the cyclone in a radially thin sheet so as to minimize the radial distance through which a particle must travel to be separated from the air stream. Therefore the discharge pipe should enter the cyclone through a transition piece whose rectangular section is at least twice as deep as its radial width. Moreover, it is important that the inlet be exactly tangent to the cyclone body. Separation is adversely affected by the lack of tangency of inlet and square-to-round as shown in Fig. 75b.

Elbows in the discharge pipe immediately preceding the cyclone can help or hinder separation. Thus, an elbow such as Fig. 75c encourages centrifugal separation because the elbow concentrates the dust on the outside of the bend. When the direction of rotation of the bend is opposed to that of the cyclone, as in Fig. 75d, the dust load is introduced into the cyclone at the maximum distance from the cyclone wall.

Cyclones in Tandem

Two identical cyclones connected in series offer little advantage over a single cyclone. Since the separating forces are identical in the two, the second can precipitate no smaller particles than can the first. This is confirmed by a test wherein a single cyclone captured 94% of a certain dust and two in series raised the collecting efficiency to only 96%.

Filters

The air cleaner most widely used for the extraction of dangerous dusts of small dimensions is the cloth

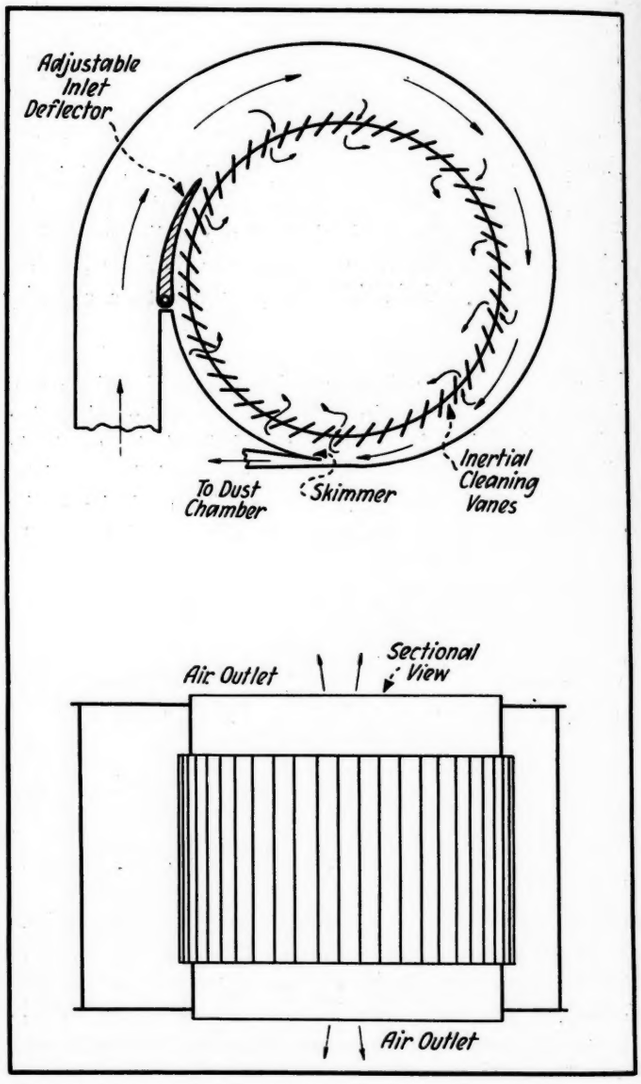


Fig. 72. Tangential cyclone with inertial cleaning vanes.

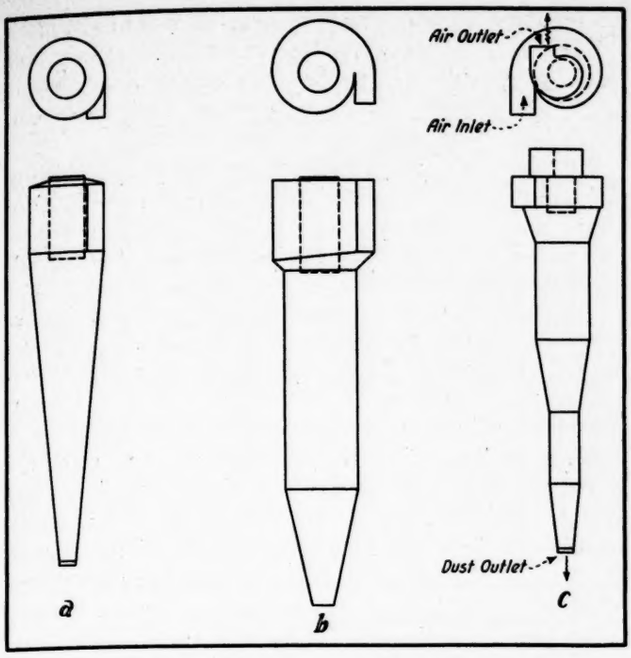


Fig. 73. High efficiency small diameter cyclones.

filter, either of the bag or screen type. When well engineered and maintained, filters are capable of collecting 99% or more of dusts as small as 0.5 microns. In spite of the high efficiency expressed as the ratio of weight collected to weight fed, the quantity of dust escaping may be sufficient to create hazardous concentrations in the cleaned air. Hence, it is well to convert the manufacturer's quoted efficiency into weight of dust escaping per cubic foot of cleaned air and to compare this value with the most recent limits of maximum permissible dustiness established by workers in this field.

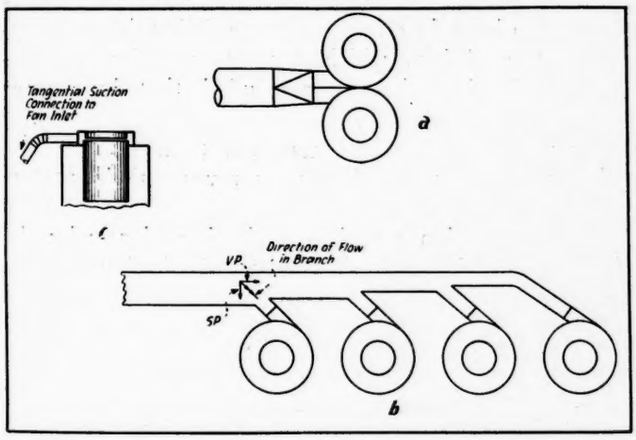


Fig. 74. Multiple cyclones.

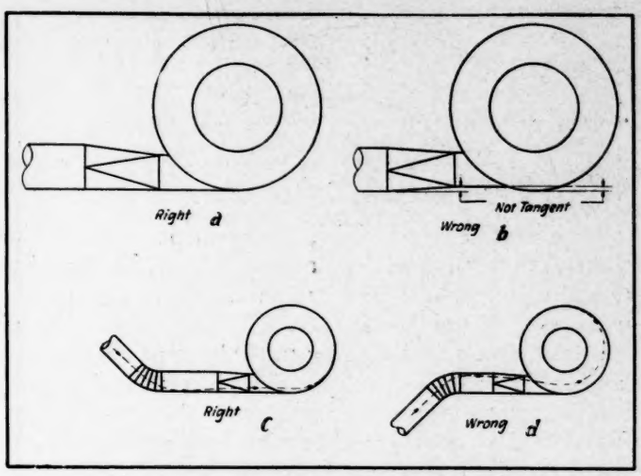


Fig. 75. Cyclone inlet arrangements.

Air Velocity Through Filter Cloth

The optimum velocity through the filter medium depends upon the dust loading of the entering air, the plugging characteristics of the dust, the maximum allowable pressure drop, the frequency of cleaning and other factors. The air volume per square foot of cloth varies from ½ to 6 c.f.m. in commercial filters although Drinker and Hatch[2] report occasional filters operating successfully at a flow rate of 9 c.f.m. per sq. ft. of cloth. A filtration rate of 4 f.p.m. is usually satisfactory for the recovery of precious metal polishing dusts, foundry dusts and pulverized mineral dusts such as cement, feldspar, limestone and similar materials. The current New York code prescribes not more than 2 c.f.m. per sq. ft. when handling lead dusts.

Filter Resistance

The filter is inherently a high-resistance cleaner. Its filtration efficiency depends to a considerable extent on the accumulation of deposited dust. The formation of the dust mat, on the other hand, increases the resistance substantially. The pressure drop is greatest just before the filter is shaken and is lowest immediately after cleaning. The greater the frequency of shaking, the less is the variation of resistance and, hence, of hood suction. While a low pressure drop is preferred for reasons of operating economy, it is seldom less than 2 in. of water and often reaches 4 or 5 in.

Air flow through filter cloths takes place as laminar or streamline flow. Hence the pressure drop through the filter medium is proportional to the velocity. Resistance imposed by inlet baffles and at the filter outlet is proportional to the square of the velocity.

[2] "Industrial Dust," by Drinker and Hatch, McGraw-Hill, p. 245.

New Cooling Experiments in London Subways

TWO interesting experiments are being made by the London Passenger Transport Board with a view to controlling further the temperature of the London subways. The first is being made at Trafalgar Square station in the heart of London. Apparatus is being installed to inject water vapor into the station. The vapor will absorb heat and the cooled air will be forced along the tunnel by trains travelling to the next station.

The second experiment is being made at Tottenham Court Road station, which connects the city with the northern suburbs. Here a large refrigerator is being installed in a disused elevator shaft to circulate cold fluid through a system of pipe grids. Electric fans behind the grids will blow cool air into the system.

EDITORIALS

Water Temperatures in Summer

In this issue we publish a statement showing the summer water temperatures reported from a long list of cities during a recent summer. This information, gathered and published by Department of Commerce efforts, should go a long way toward supplementing the lamentable scarcity of information about available summer water temperatures which caused so much confusion in the early days of comfort cooling. These temperatures do not show the extremes which may be encountered but they do furnish a good basis for estimating and at least should help in avoiding estimates based on wholly impossible conditions.

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Oil Burners as Merchandise

More and more of the manufacturers of merchandise equipment aimed at the residence market are offering oil burners carrying their own name. With the recent announcements that the radiator companies also will put out these burners, the oil burner for residences can be said to have become fully a merchandise article. Originally the pioneer burner manufacturers had a specialty and treated it as such for they found it necessary to build up their own selling, installation and service organizations. Each passing year has seen the slow trend toward merchandising of burners continued. Now there are but few makers of domestic equipment who do not include an oil burner as one of the merchandise items which they catalogue. Frequently the manufacture of parts and the burner assembly are still in the hands of the specially equipped parts makers but the disposal, erection, and service are largely turned over to the merchandisers.

There is nothing unusual in this situation for nearly all equipment starts out by being a specialty with but limited acceptance, passes to a merchandise item, and finally ends up as a premium if it stays in popular use long enough to reach the third stage. The oil-burner, everything considered, continued as a specialty rather longer than might have been anticipated.

As a merchandise item the future course of the oil burner can be easily predicted although the rate at which the course will be run can not be prophesied. Both the consumer price and the profit margin to manufacturer and seller can be expected to steadily fall. Sales will steadily tend to pass into the hands of a few firms best equipped to accomplish them. Service and installation work will become more and more a matter of pure routine as time goes on. Replacement will furnish a steadily increasing proportion of the total installations. Less and less can a self-supporting retail business be built on taking over the agency for a manufactured oil burner alone.

Finally, when the process has run its natural course the only parties particularly interested in pushing the additional use of oil-burners will be the fuel interests. At that time the beginning of the "premium" stage will be at hand.

Especially during its early stages, while it was gaining a market foothold, and when its development was in the hands of the pioneer makers the oil burner staged a real upheaval in residence heating. Its achievements in securing dependability in operation, in obtaining quiet running, in automatic ignition, in efficient combustion, in gaining acceptance for intermittent operation, and especially its giving real impetus to the development of automatic controls, all stand as very real contributions to the art of heating. All were accomplished in the face of a lackadaisical attitude on the part of the industry generally and the more credit is due to these innovations on this account. It will be interesting to see if in the merchandise stage an equally impressive and lasting record can be made.

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Equipment Rating

Several recent developments have brought the subject of standard equipment testing and rating to the front. The Bureau of Standards last month decided to investigate boiler and radiator ratings; the Stoker Manufacturers' Association has adopted a standard stoker rating formula; at Hot Springs the ASHVE ratified its proposed code for testing stoker-fired steam heating boilers, and the last organization also heard a discussion of its filter testing and rating code. This discussion brought out forcibly the difficulties in selecting test conditions which simulate practical requirements; the investigators concluded that by proper choice of the constituents of the test dust one type of filter may give far better results than other filters, whereas another test dust may reverse their relative merits.

This conclusion explains to the impatient why the framing of rating codes is a slow and laborious process requiring careful deliberation of experienced specialists.

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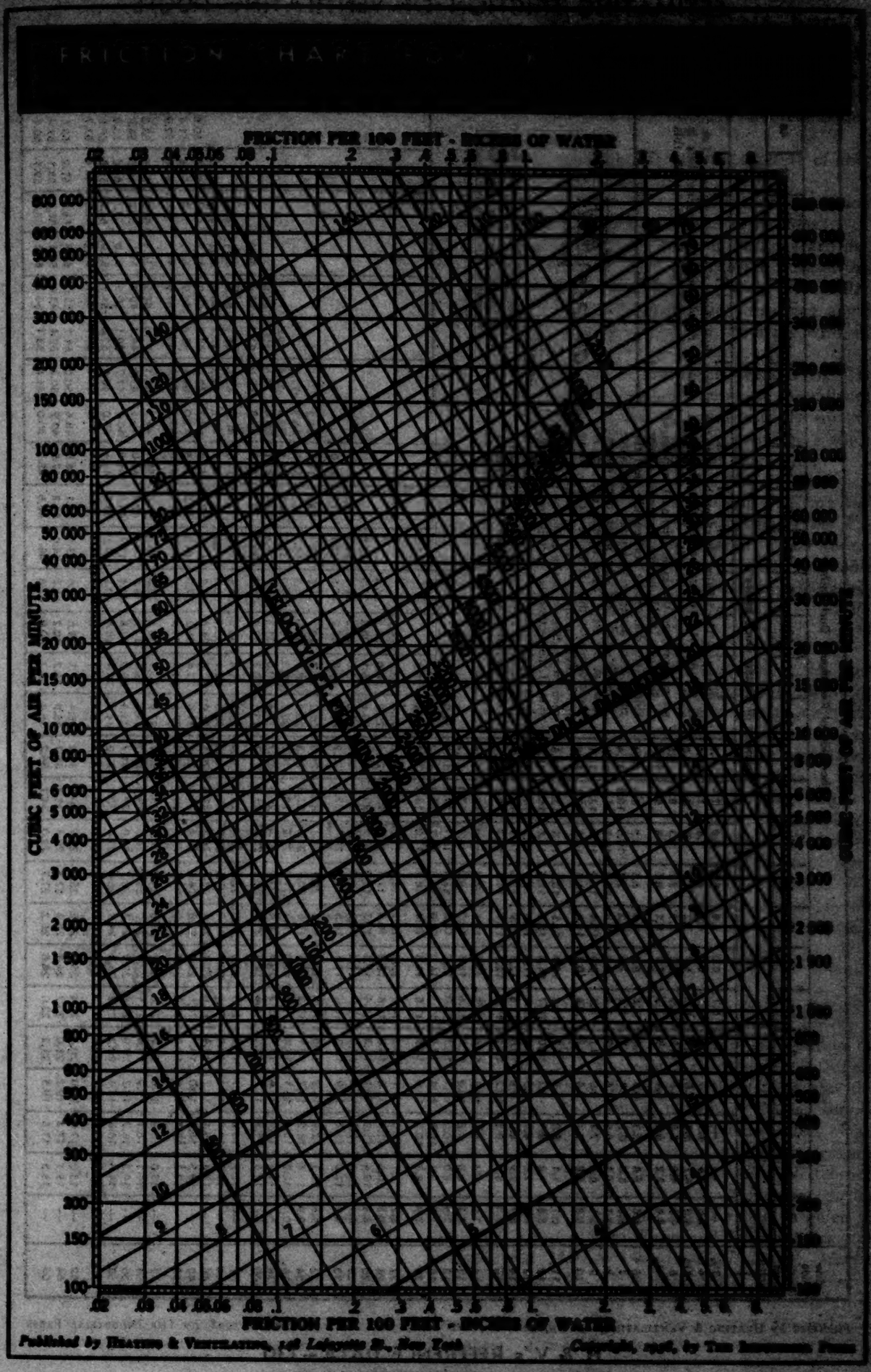
Self-Contained Coolers in the Lead

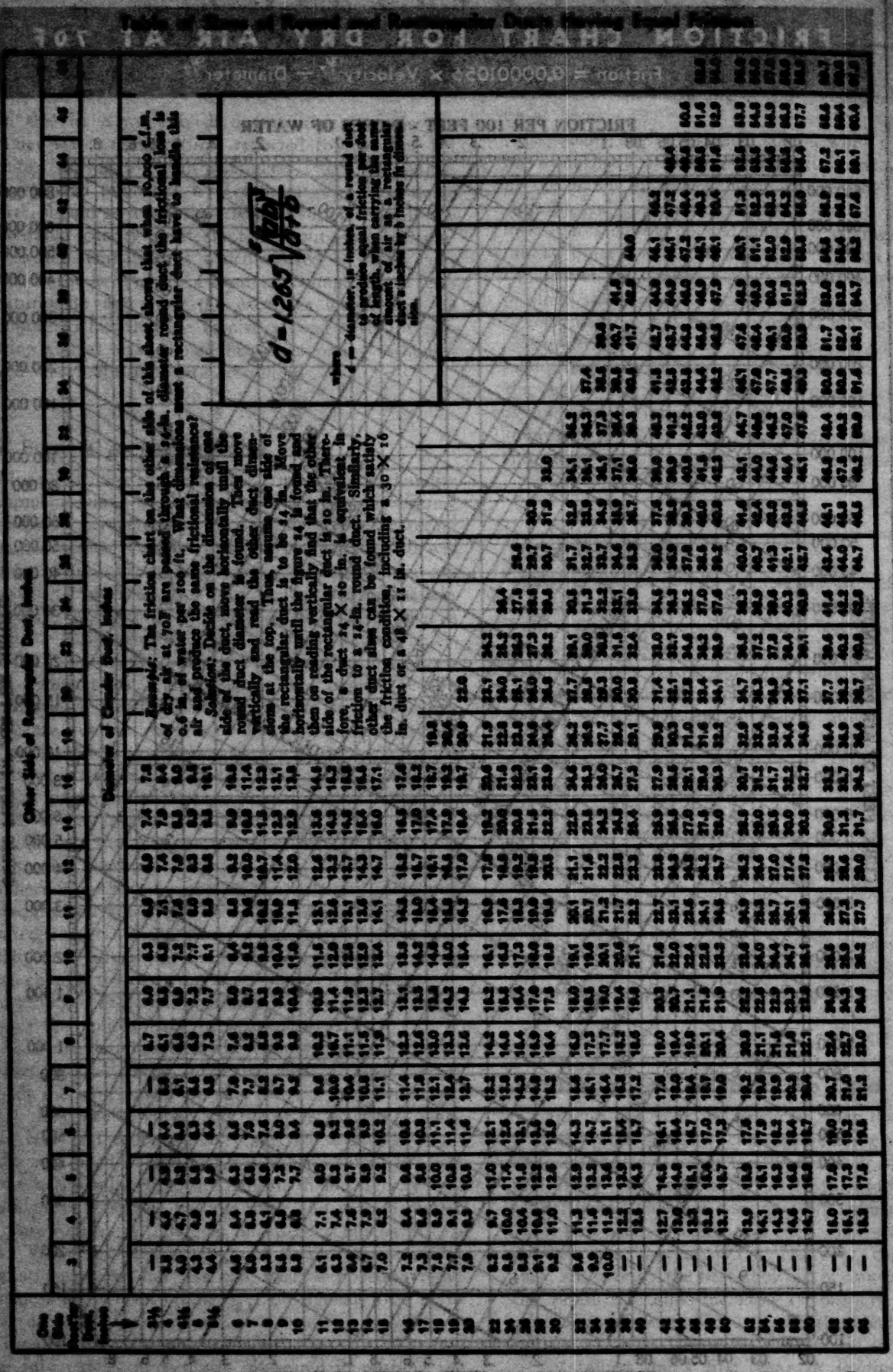
Early in the year we predicted that this would be a good year for the self-contained cooling units. Now figures on sales volumes for the first four months show that these units are nearly up to their dollar volume of last year. This is a disappointing showing in a way for it had been expected that their sales volume would go well over that of 1937. However, comparatively they are making the best showing of any of the quantity production units including oil burners and stokers which have held the lead in the spectacular sales increases made in late years. This still looks like the self-contained unit's first year in leading the sales procession.


FRICTION PER 100 FEET - INCHES OF WATER
CUBIC FEET OF AIR PER MINUTE
VELOCITY IN FEET PER MINUTE
FRICTION PER 100 FEET - INCHES OF WATER
Published by Heating & Ventilating, 148 Lafayette St., New York
Copyright, 1926, by The Industrial Press

H. & V.'s REFERENCE DATA—129

ESTIMATING FRICTION OF VENTILATING DUCTS

Table of Sizes of Round and Rectangular Ducts Having Equal Friction


FRICTION CHART FOR DRY AIR AT 70°F
FRICTION PER 100 FEET - INCHES OF WATER
Friction = 0.0000258 × Velocity² ÷ Diameter⁵
d = 1.265 √(f Q²/Δp)
where d = diameter, in inches, of a round duct to produce equal friction per foot of length, when carrying the same amount of air as a rectangular duct a inches by b inches in dimension.
f = friction factor
Q = cubic feet per minute
Δp = friction per 100 ft.
Example: The friction chart on the other side of this sheet shows that when 10,000 c.f.m. of dry air at 70°F are passed through a 24-in. diameter round duct, the frictional loss is 0.5 in. of water per 100 ft. What dimensions must a rectangular duct have to handle this air and produce the same frictional resistance?
Solution: Decide on the dimension of one side of the duct, above horizontally until the round duct diameter is found. The more vertically and read the other duct dimension on reading vertically and that the other side of the rectangular duct is to be 24 in. Therefore, a duct 24 × 10 in. is equivalent in friction to a 24-in. round duct. Similarly, other duct sizes can be found which satisfy the friction condition, including a 30 × 16 in. duct or a 48 × 11 in. duct.
Other Side of Rectangular Duct, Inches
Diameter of Circular Duct, Inches

Published by HEATING & VENTILATING, 148 Lafayette St., New York Copyright, 1938, by THE INDUSTRIAL PRESS

H. & V.'s REFERENCE DATA—130

ABSTRACTS of Current Papers, Books and Pamphlets

Exhaust Systems

The fundamentals of design, construction, operation and maintenance of exhaust systems is the subject of the most recent publication of the Industrial Hygiene Codes Committee of the American Foundrymen's Association. This committee has a program which calls for the publishing of a series of codes for the control and abatement of occupational diseases. Previous publications of this series were entitled: "The Tentative Code of Recommended Practices for Grinding, Polishing and Buffing Equipment Sanitation" and "The Tentative Code for Recommended Practices for Testing and Measuring Air Flow in Exhaust Systems."

This new code gives complete engineering information which is essential in the proper design and construction of exhaust systems. It is felt that this book will do much to improve the design and installation of future exhaust systems as it presents actual engineering data to replace the rule-of-thumb methods which are frequently used at the present time.

Considerable research work was performed in developing this code with the result that entirely new information and data are included on resistance losses or friction in straight pipes and elbows. The committee found that in many instances published information on this subject was incorrect.

The appendix gives an example of an exhaust system completely worked out, step by step, showing the proper use of all the rules and formulas given in the text. Among the subjects covered by this book are the following: theory of air flow in exhaust systems; application of exhaust systems; application of collection equipment; air flow producing equipment; designing exhaust systems; construction specifications; vacuum cleaning equipment; and operation, supervision and maintenance of exhaust systems.

[*"Fundamentals of Design, Construction, Operation and Maintenance of Exhaust Systems," by the Industrial Hygiene Codes Committee of the American Foundrymen's Association, 222 W. Adams St., Chicago. Flexible binding; 8½ x 11½ in.; 141 pages; price, $4.*]

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Pressure Losses in Air Ducts

Owing to structural peculiarities and limitations, or to changes in the quantity of air being carried, changes in the cross-sectional area of ducts conveying air frequently become necessary. In designing duct systems data on the pressure losses resulting from such changes are necessary in order to evaluate the total resistance to the flow, a reasonable accurate estimation of which is required for the proper selection of fans and motors.

The investigation which is described in this bulletin had for its object the determination of the losses in total head, or total pressure, otherwise called "shock loss," resulting from abrupt changes in the cross-sectional area of an air stream, or occurring in various transition sections connecting ducts of different diameters.

Among the conclusions reached as a result of this investigation are the following:

(1) The shock losses in abrupt contractions are much smaller than those caused by abrupt expansions.

(2) The shock losses in diverging sections are dependent on the angle included between the sides of the section, the smaller losses occurring with the smaller angles; and the loss with an included diverging angle greater than 60° is as great as that occurring with an abrupt expansion.

(3) The shock losses in converging sections are also dependent on the angle included between the sides of the section, the smaller losses occurring with the smaller angles; and the loss with an included converging angle of 60° is less than that in an abrupt contraction.

[*"Pressure Losses Resulting from Changes in Cross-Sectional Area in Air Ducts," by Alonzo P. Kratz and Julian R. Fellows. Bulletin No. 300, Engineering Experiment Station, University of Illinois. Paper cover; 6 x 9 in.; 58 pages; price, 65 cents. Copies obtainable without charge until December 15 or until supply available for free distribution is exhausted.*]

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Oil Burners. A newly-revised edition of this well known study on oil burners as applied to domestic heating. The purpose of this study was to meet the demand of prospective purchasers of domestic oil burners for reliable information. Includes information based on the results of a large number of tests from oil burners. This bulletin deals with the technical phases of the investigation. [*"A Study of the Oil Burner as Applied to Domestic Heating," by Arthur H. Senner. Published by the United States Department of Agriculture, Washington, D. C. Technical bulletin No. 109. Paper cover; 44 pages; 6 x 9 in.; for sale by the Superintendent of Documents, Washington, D. C.; price, 10 cents.*]

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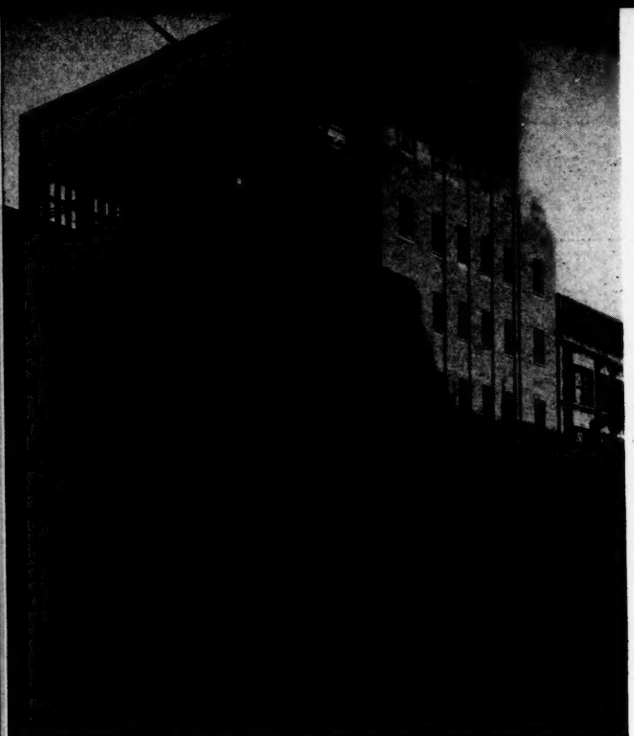
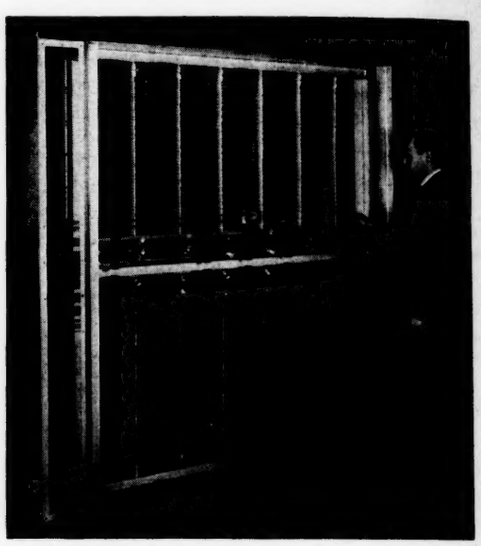
Water. Statistics and comments on the available water supply in cities in the United States having a population of 20,000 or more. Gives information on sources of water, population served by water supply systems. daily delivery capacity of systems and delivery of water and percent of annual change, service capacity of present water works systems, effect of air conditioning installations on water supply, temperature of water at mean outlet and normal mean air temperatures for the months of April to September during 1936. A lengthy discussion on this report is given on page 39. [*"Effect of City Water and Sewerage Facilities on Industrial Markets" by O. C. Holleran. Market Research Series No. 17, United States Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C. Paper cover, 8½ x 11 in., 100 pages. Price 10 cents.*]



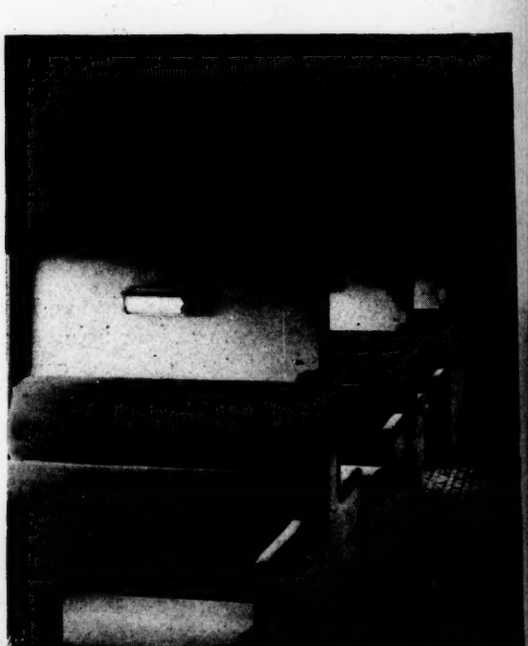
TUNNEL VENTILATION building on West 178th St., New York. This building will supply the ventilation air for the tunnel which will carry traffic from the George Washington Bridge cross-town underneath Manhattan Island. Photo courtesy The Port of New York Authority.

RADIO SCRIPT WRITERS for recent Ilg Electric Ventilating-Chicago Board of Education broadcast on vocational possibilities in the air conditioning industry. Left to right: Arthur Sutcliffe, chief engineer, and Walter Rietz, vice-president, of Ilg, and Ken Ellington, Station WBBM.

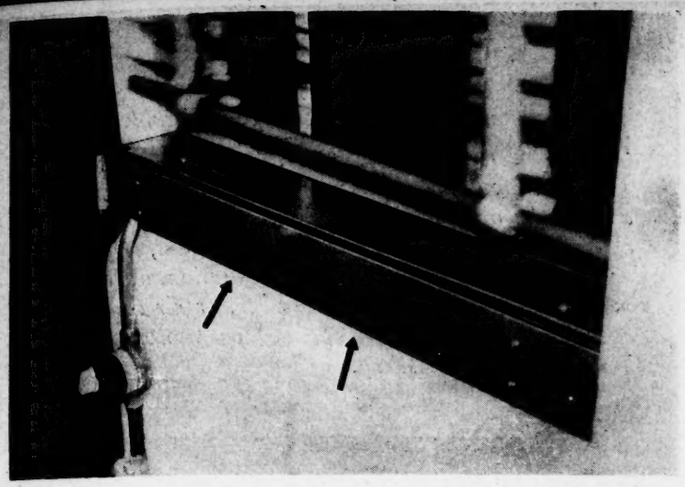


A 168-KW electric heating unit used as a pre-heater in the inlet of the air washing system at the Bonneville Dam, Oregon. Photo courtesy The American Foundry Equipment Company.

HOT HEADS COOLED by this air conditioned hat. Electric batteries in inventor's pocket run electric motor on top of hat which drives small fan on inside of hat.

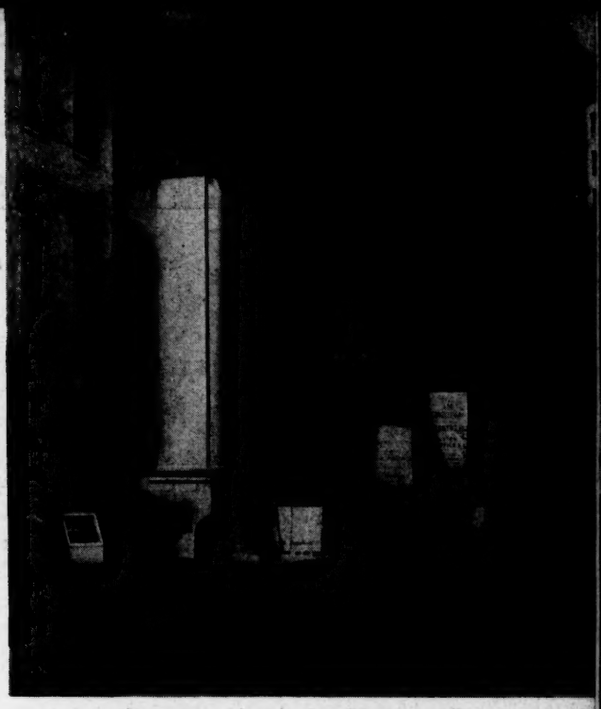


THE THIRD "REBEL," streamlined diesel train o the Gulf, Mobile and Northern Railroad designed an built by American Car and Foundry Co. The car ha an air conditioned system with a six-ton compressor Distribution of the conditioned air is through over head units in center ducts in the sleeper sectio There is independent control of air for each bert



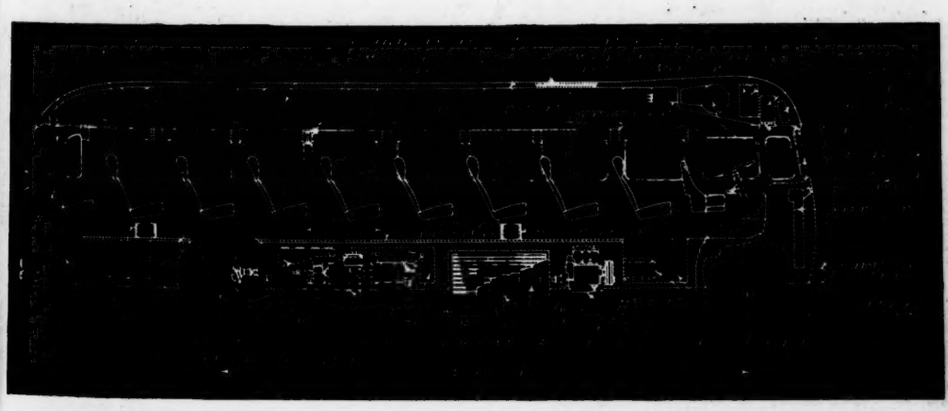
ELECTRIC HEATED WINDOWSILL. Electric strip heaters on window sills prevent cold air spreading over floors in offices of a silk company. Heaters are controlled by a three-heat switch. Photo courtesy Edwin L. Wiegand Co.

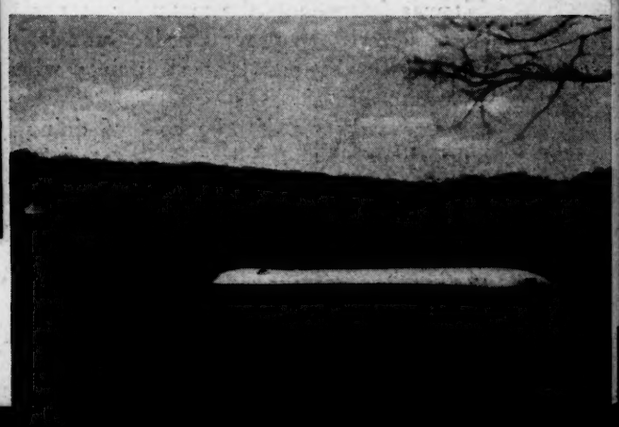
Picture Paragraphs



DRILLING FOR WATER in New Orleans. A drilling rig erected on the sidewalk to tap underground well water. The water will be used in air conditioning the Hibernia Bank Building. The installation was made by the C. Wallace Plumbing Co., Dallas, Tex.

MEDIEVAL AIR CONDITIONING. The print above shows a "combination body fanner, nutcracker, and wine helper for the heats of summer," as delineated in a 100-year old lithograph. At the right is shown a fan of the period of 1663, said to be the earliest known mechanical device for air circulating.





WEATHER-WISE BUSES. Forty-five air conditioned buses, illustrated above and right, costing $1 million are now in operation in the southwest by the Santa Fe Trailways. The conditioning system cools, dehumidifies, and circulates 1100 c.f.m. The cooling capacity is 3½ tons when it is 110F outside. The buses were built by American Car and Foundry Motors Co., with special Carrier air conditioning.

KINKS

Eliminating Noise in an Auditorium Supply Fan

A Cleveland, Ohio, high school has a supply fan for the auditorium which developed a noise which was so annoying that it was necessary to shut it off when the room was in use. At first it was feared that it would be an expensive job to correct this difficulty but by the exercise of a little ingenuity the noise was entirely, and permanently, eliminated by an expenditure of only $50.

A survey of the situation showed that the fan has a horizontal discharge and that it handles 50,000 c.f.m. It was properly installed on a sheet cork foundation sandwiched between planks in the attic over the second floor classrooms, and approximately 75 ft. from the auditorium ceiling. The discharge duct coming from the fan is in the form of a Y which runs horizontally over the attic floor with branch ducts dropping down and crossing the ceiling of the auditorium to large ornamental plaster grilles. The latter are approximately 9 ft. square with a free area of about 20%, and having a very rough finish on the inside of the openings. The walls of the auditorium are hard and the ceiling is of plaster. The discharge duct of the fan is connected to the main duct by means of canvas.

The roaring noise in the auditorium, it was found, was caused by the impact of the air wherever it struck the sheet metal duct system, and the hum of the motor was telephoned through in this way. There was no noise due to vibration of the fan, but the noise caused by the air in the fan was carried through the ducts by the impact.

One way to eliminate this noise would have been to insulate the entire duct system, but this would have been an expensive procedure. Consequently, a very much more simple and less expensive method was tried, and it proved to be very effective. This consisted of the use of 1-in. thick felt placed at strategic points in the ducts.

First a strip 1 ft. wide was placed around the inside of the main discharge duct about 2 ft. from the canvas connection, on the side away from the fan. Then at the Y branch, a short distance away, the V portion was covered with a strip of felt 2 ft. wide. In addition to this the curved portion of each elbow where the branch ducts turn down toward the auditorium ceiling, and also where they turn out over the suspended ceiling, was covered with felt on the inside. A portion of the elbow and Y in the branch duct lines leading to the ceiling grilles was also covered with felt, as well as at all dampers. Felt, provided with the necessary openings, was also placed over some of the grilles. In each case the felt was fastened to the metal by means of sheet metal drive screws. In other words, the felt insulation was place over the metal at all points where there is a direct impact of air.

As already stated, the cost of doing this job was only about $50 for labor and material. It completely eliminated the noise so that no one could tell whether there was a fan in the building or not, so far as hearing it is concerned.—*E. O. Young, President, E. O. Young Company, as told to Francis A. Westbrook.*

Liberal payment will be made for brief articles which are, in the opinion of the editors, useful and generally applicable kinks relating to drafting room, shop, plant, or field practice in the design, installation, operation, or maintenance of heating, ventilating, or air conditioning equipment. Sketches (in pencil) or photos should be included when necessary.

THE PROBLEM CORNER

A water tank was equipped with a supply pipe and a drain pipe, each a different size. If, when the tank was half full of water, the valves on both pipes were opened and left open, the tank would be empty in 12 hr. Later two new pipes were installed sufficiently smaller so that the new supply pipe would require one hour longer to fill the tank and the new drain pipe one hour longer to empty it. With the tank full of water and the valves on both new pipes opened and left open, the tank then was emptied in 15¾ hr. How long did it take the *old* supply pipe to fill the tank, and the *old* drain pipe to empty the tank?

If you are doubtful of your solution, see page 71.

THE MONTHLY QUIZ

How many of the following teasers can you answer offhand? Only one of the answers given after each question is correct. Check your answers against those appearing on page 70

1. A Ringelmann chart is used for (1) indicating relative smoke density (2) showing per cent of heat lost up the stack (3) converting specific gravity of oils from degrees Baume to degrees A.P.I. (4) showing heat content-temperature relationships of gases (5) solving pipe friction problems.

2. Under pressures higher than the atmospheric, the boiling point of water rises. The freezing point of water (1) increases slowly as the pressure increases (2) increases rapidly as the pressure increases (3) decreases slowly as the pressure increases (4) decreases rapidly as the pressure increases (5) remains at 32F.

3. A eupatheoscope measures the (1) ambient air temperature (2) percentage of hydrocarbons in fuel (3) total pressure in an air duct (4) rate of heat required to maintain the human body at the desired temperature (5) superheat in a refrigerant.

4. The temperature of adiabatic saturation is the (1) dry bulb temperature (2) dewpoint temperature (3) wet bulb temperature (4) critical temperature (5) absolute temperature.

5. When flue gases are analyzed in an ordinary field Orsat, the sulphur dioxide is indicated with the (1) oxygen (2) carbon monoxide (3) hydrogen (4) nitrogen (5) carbon dioxide.

NEWS OF THE MONTH

Heating Contractors Elect Dickerson President, Olvany Treasurer; 400 Registered at Lively Convention in Boston

BOSTON—"Build your business to meet your customers' needs and you can make your business grow in spite of the depression," Prof. Edmund P. Learned, associate professor of marketing, Harvard University, told contractors assembled in the Hotel Statler here for the 49th annual convention of the Heating, Piping & Air Conditioning Contractors National Association May 31-June 2. According to Professor Learned the contractor should not be afraid to take responsibility for the whole job of giving satisfaction and selling comfort. In line with this he recommended that the contractor undertake a three-point program which would consist of:

(1) Broadening his line to solve all heating and cooling problems; (2) take the trouble to know thoroughly his whole line; (3) take full responsibility for the job.

Approximately 400 contractors and their guests registered at the convention. Carefully prepared committee reports and a number of interesting and informative talks on sales, overhead and conditions within the construction industry featured the convention.

Arthur Reilly, Fire Commissioner of Boston, opened the convention on Tuesday morning, May 31, with an address of welcome. Following this was the presidential address by H. Merwin Porter and a talk on the business outlook by Arthur C. Babson of the Babson Statistical Organization. Mr. Babson predicted that business would be considerably improved by the end of the summer and that construction this year will be approximately 10% below the 1937 total. Reports of the treasurer and the auditing committee concluded the morning session.

During the afternoon sessions the members heard reports of the secretary, membership committee, committee on welding and a report on the Plumbing and Heating Industries Bureau. William D. Halsey, assistant chief engineer of the boiler division, Hartford Steam Boiler Inspection and Insurance Co., then addressed the convention on an insurance company's attitude toward inspection and insurance of welded pipe lines. Following this was a film entitled "Green Lights Ahead" which was presented by Anthracite Industries, Inc.

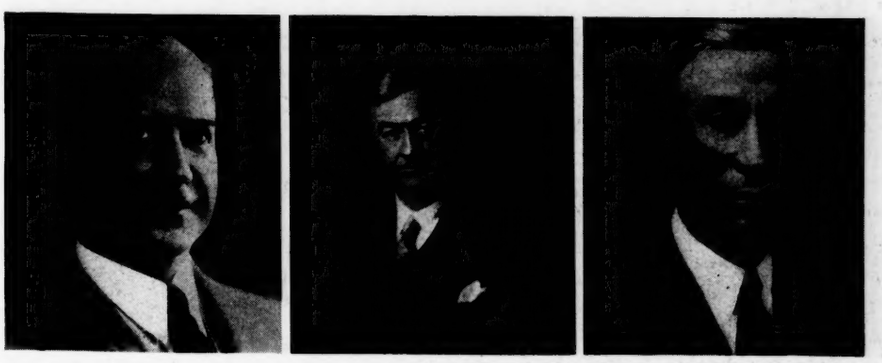
Reports presented on Wednesday morning included those of the committee on legislation, committee on air conditioning, trade promotion, boiler output committee and committee on standards. The feature address of the morning was the talk by Professor Learned.

Thursday morning William Stanley Parker, architect and general chairman of the Construction League, presented a highly informative talk on the construction industry. In his address he stated that while the construction industry in 1929 was the largest industry in the country, and even now was one of the largest, only a small amount of work is being done to gather statistics on it. It was his idea that the government spend approximately $100,000 a year gathering information on the construction industry. He also recommended that public expenditures for construction be stabilized so that the volume can be kept up during times of depression to eliminate the wide fluctuations that this industry is now subjected to.

Also presented during the Thursday morning session were committee reports on industrial relations and certification. The members also heard a highly informative talk on overhead and profit by Prof. Henry J. Bornhofft of Boston University. In his address Professor Bornhofft reviewed some of the principles of accounting as applied to contracting and gave some interesting figures on overhead and profit of various contractors.

During the afternoon session reports of the committees on apprenticeship and the 50th anniversary were heard. During this session the following officers were elected for the year of 1938-1939: President, George H. Dickerson, Chicago, Ill.; vice-president, Frank E. Kise, Cincinnati, Ohio; and treasurer, William J. Olvany, New York. The following members were elected to the board of directors: Frank E. Kise, William J. Olvany; J. E. McNevin, Denver; A. C. Rodoni, San Francisco; L. L. McConachie, Detroit.

The social portion of the convention was judged by members to be a great success. This included a Boston Tea Party in Colonial style on Tuesday evening, a golf match, a sight-seeing trip and a dinner-dance.



New officers of the Heating, Piping & Air Conditioning Contractors National Association: l. to r., G. H. Dickerson, president; F. E. Kise, vice-president, and W. J. O vany, treasurer.

Stoker Builders to Study Cast Boilers, Establish Data on Setting Heights

HOT SPRINGS, VA.—E. C. Sammons, vice president, Iron Fireman Manufacturing Company, was elected president at the 1938 annual meeting of the Stoker Manufacturers' Association, held here June 16-17. The conference reviewed many important problems and projects which have been under consideration for many months.

In making his final report to the Association, retiring President Ray C. Goddard briefly commented on the state of affairs in the stoker industry and the many problems on the docket for consideration.

The association adopted standard recommendations covering free service and replacement parts guarantee based upon a study of current trade practices of its members.

The engineering committee was authorized to proceed to undertake a survey covering cast iron boiler setting heights and furnace dimensions and to bring together allied industries interested in the establishment of data and facts on which to base the intelligent application of stokers to cast iron boilers in an effort to meet the requirements of the nation's smoke abatement authorities.

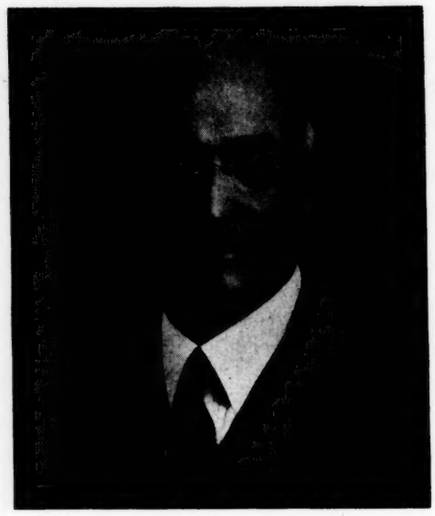
At an open session representatives of allied industries presented short and interesting papers on subjects of interest to the stoker industry. The control industry was represented by Albert Penn, president, Penn Electric Switch Company; Appalachian coal operators by Julian E. Tobey, manager, fuel engineering division, Appalachian Coals, Inc.; the boiler business by W. B. Hughes, manager, automatic heating boiler division, American Radiator Company, and water heaters by E. J. Gossett, president, Bell & Gossett Co.

300 Warren Webster Employees Meet to Honor Head of Firm

CAMDEN, N. J.—Warren Webster, 75, president and founder of Warren Webster & Company, was honored June 23-26 on the completion of fifty years in the steam heating business. More than 300 factory and home office employees, together with the managers of the company's sixty sales offices and Edward Darling, of Darling Bros., Ltd., Canadian affiliate, gathered in the Walt Whitman Hotel here on June 23 for the 50th anniversary dinner. The dinner, a surprise testimonial to Mr. Webster from his employees, was followed by a week-end at Atlantic City for the group.

In addition to the factory and home office employees, the following district representatives were present at the celebration:

Horace A. Bond, Albany; E. W. Klein, Atlanta; S. B. Strouse, Atlantic City; Max P. Miller, Baltimore; Haydn Myer, Birmingham; J. F. Tuttle, Boston; Wm. Roebuck, Jr., Buffalo; T. J. Sullivan, Butte; B. B. Harter, Champaign; C. E. Mills, Chattanooga; P. W. Stickney, Chicago; W. C. Green, Cincinnati; A. L. Vanderhoof, Cleveland; F. N. Schaad, Columbus; E. C. Waddington, Dallas; H. H. Herman, Denver; H. E. Drain, Des Moines; A. B. Knight, Detroit; J. N. Stipe, Easton; C. H. Morton, Grand Rapids; Fred W. Schimmel, Harrisburg; R. B. Johnson, Houston; S. E. Fenstermaker, Indianapolis; H. F. Lenz, Johnstown; B. Natkin, Kansas City; R. M. Gunzel, Los Angeles; L. F. Poehner, Louisville; T. J. O'Brien, Memphis; Harry M. Miller, Milwaukee; H. E. Gerrish, Minneapolis; H. R. Briggs, New Haven; W. H. Grant, New Orleans; John F. Hanbury, New York; H. Y. Kleinkauf, Omaha; G. R. McNamara, Orlando; Karl Rugart, Philadelphia; R. B. Stanger, Pittsburgh; B. C. Allen, Raleigh; W. W. Neale, Richmond; C. G. Traylor, Roanoke; L. M. Hakes, Rochester; E. B. Caldwell, Rock Island; W. A. Witheridge, Saginaw; T. J. Hester, St. Louis; R. C. Midgley, Salt Lake City; E. H. Goins, San Francisco; W. B. Starky, Spokane; R. H. Bacon, Syracuse; Sprague Jones, Toledo; Bert Natkin, Tulsa; S. E. Vance, Washington; James P. Newshaw, Washington; F. H. Ross, Wilkes-Barre; and Edward Darling, Montreal.



Warren Webster

Unit Heater Association to Meet

TORONTO—The third regular meeting of the Industrial Unit Heater Association will be held here July 19, with headquarters at the Royal York.

For the past two years, the engineering committee has been at work on a standardization program, a part of which became effective June 1. It is expected that additional standards will be ready for announcement after the regular meeting on the nineteenth.

12 Broadway Theaters Ice Cooled

NEW YORK—Broadway will be on ice this summer, at least as far as the theatrical portion of the Great White Way is concerned, according to Clifford F. Holske, air conditioning engineer of the American Ice Company. An even dozen of New York's legitimate theaters are now air conditioned with ice and no matter what plays the theater goer chooses to see, the chances are he'll see them in ice-cooled comfort.

Among the assortment of "iced" hits are: "I'd Rather Be Right," at the Music Box; "You Can't Take It With You," Kaufman's Pulitzer Prize Winner, at the Booth; "Shadow and Substance" at the Golden; "On Borrowed Time" at the Longacre; "Pins and Needles," musical revue produced by the International Ladies Garment Workers Union, at the Labor Stage; "The Women," now in its second year at the Ethel Barrymore; "Room Service" at the Cort, and "What a Life" at the Biltmore.

Mr. Holske estimates that five thousand tons of ice will be used this year to keep these theaters cool and comfortable. At least an equal amount will be used to cool off night club and restaurant patrons in the white light section.

Last year American Ice Company sold 110,000 tons of ice for air conditioning.

Bulkeley Opens Philadelphia Office

PHILADELPHIA—Claude A. Bulkeley, for the past ten years chief engineer of Niagara Blower Co., and widely known as the author of the Bulkeley psychrometric chart, is now acting as consultant and sales engineer for the company, having opened his own sales and consultant office here at 2045 No. Broad St.

The 50th anniversary dinner of the Warren Webster & Co. organization

Warm Air Heating Group Holds Summer Meeting in Milwaukee; Kingsland, Kratz, Larson and Konzo on Program

MILWAUKEE—President L. R. Taylor opened the mid-year meeting of the National Warm Air Heating and Air Conditioning Association, held here June 14-15, with a plea to keep the business in the hands of legitimate operators where it belongs.

Prof. G. L. Larson, University of Wisconsin, in discussing the importance of research, declared that an industry without scientific problems is headed for ruin. "Science is advancing so rapidly that industry must undertake research, if it wants to keep abreast of the times," he said.

Manufacturers must be made to understand that this country is in the midst of an industrial revolution, he continued, pointing to the state of flux existing in the paper, paint and fuel industries as the result of new developments. The importance of research in meeting changing conditions was emphasized by Professor Larson, declaring that "in the industrial revolution which the handwriting on the wall portends, the industrial engineer will be on the firing line."

Substituting for H. T. Richardson, A. P. Ames, Ames & Norr, New York, discussed "A Practical Plan of Advertising," in which he outlined the results of a demonstration publicity campaign carried on during the past 30 days by his firm for the industry.

Prof. L. G. Miller, Michigan State College, as the final speaker on the opening session, discussed "Design the Walls for Both Heat and Vapor Transfer." In his address, Professor Miller emphasized three issues, namely, a method of analysis, the quantity of vapor passing through a wall, and the proposed corrective methods.

Principal speakers on the Tuesday afternoon program included Prof. J. D. Hoffman, Lafayette, Ind., who discussed "Our Installation Codes"; R. B. Engdahl, research assistant, University of Illinois, who discussed the results of an experiment at the research residence relative to the position of the bonnet thermostat in a gravity system; A. P. Kratz, research professor, University of Illinois, who spoke on "Pressure Losses in Elbows and Changes in Section," and S. Konzo, special research assistant professor, University of Illinois.

Reasons why bonnet thermostats fail to function properly, according to Mr. Engdahl, included stratification of air, radiation of hot surfaces and lag. Tests were made with the thermostat located 7, 13, 19, and 24 in. above the furnace dome, and charts were used to show the different results in each instance.

Charts mapping pressure diagram for fan and duct system, difference between velocities in small and large ducts and friction loss in transition fittings were included in the address by Professor Kratz, which summarized the work carried on in connection with several recent tunnel installations.

To overcome difficulties encountered where square elbows are required, Professor Kratz recommended the use of turning vanes, preferably six or seven. He contended that it was his belief that there was not much efficiency in the use of less than three such vanes in an elbow.

Professor Konzo explained the results obtained in the test made in the research residence at Urbana, Ill., of stoker versus hand firing. The duct system used was the same as with other systems, while the stoker was of the ordinary commercial screw type, ¼-hp. motor and fitted with a 300-lb. hopper, he stated.

It was attempted to maintain as many conditions equal as possible for both types of firing, although a hold-fire time switch was added for stoker firing, the speaker said.

"Hand firing was done four times a day and ashes removed once a day," Professor Konzo declared. "Stove coal was used and the comparison made between well operated hand firing as opposed to less scientific hand firing, in which case the results would undoubtedly have been different from those which we obtained."

The tests showed that the temperature overruns in the second and third stories of the home were pretty well eliminated by stoker firing. At the same time, although rigid control of room areas and bonnet area temperatures were possible when the stoker was operating, during off-periods there was considerable burning with little control possible, the speaker continued.

Consumption of coal varies according to whether the over-fire damper in the case of stoker firing was open or closed. In the former case, the stoker firing consumed 180 lb. of coal per hour and in the latter 130 lb. compared with 165 lb. for hand firing, Professor Konzo explained.

The test conducted during an average 40F indoor-outdoor temperature found the stoker operating four hours per day and the difference in attendance time approximately eleven minutes per day in favor of stoker firing. Although there was found to be an increase in smoke after the stoker had shut off, for the most part stoker firing produced less smoke than hand firing, according to their findings.

He concluded his address with motion pictures showing the fuel bed burning while the stoker was in operation and after it had been shut off, both with the over-fire damper open and closed, to demonstrate the height of flames and the amount of smoke given off.

The Wednesday morning session opened with a sound motion picture, "Romance of Iron and Steel," shown through the courtesy of the American Rolling Mill Co., Middletown, Ohio.

Following the presentation of the motion picture, Vice-President C. A. Olsen, serving as chairman of the session, urged the support of all members in the association's research program, declaring it was worthy of being enlarged.

Discussing "Cooling Controls for the Residence," G. D. Kingsland, vice-president, Minneapolis-Honeywell Regulating Co., declared that manufacturers are now concentrating their efforts on ways and means of reducing cost of air conditioning equipment and installations. He predicted that summer cooling will eventually come within the price range of the better homes.

Augmenting his talk with slides to map the various types of automatic controls, Mr. Kingsland pointed to the trend toward elaborate control panels, declaring that while they added to the cost of the equipment, they also offered a very definite sales appeal to the public.

"Residential cooling can be made an important factor in the air conditioning industry," Mr. Kingsland said. "I express the desire of the control industry to cooperate with you manufacturers not to decorate your systems but to give the equipment brought to the front the opportunity to deliver to homeowners the results you have conscientiously put into that equipment."

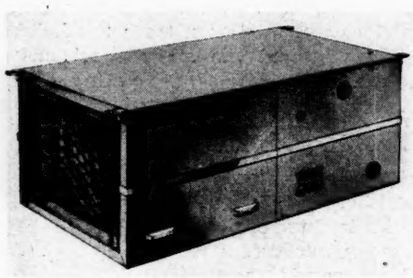
Concluding speaker was Edwin A. Jones, L. J. Mueller Furnace Co., Milwaukee, who urged cooperation as a means of maintaining the position the industry now enjoys.

"In the final analysis, no industry has anything to sell beyond integrity," Mr. Jones stated. "Let us not sacrifice what has been accomplished, but rather let us maintain and improve the position of our industry and unite for higher standards.

"Prosperous competition helps an industry. No one gains when sales are made without a profit. Ours is an engineering more than a merchandising problem. Success of the industry depends on satisfactory installations as much as equipment. We must be careful with our claims and not make overstatements.

"If a profit can't be made on a job, let someone else take it. Do not worry about the loss of a job today. It is better to lose one such job today than ten next year. Study your business, realize the facts, stick to the truth and the public will be satisfied."

NEW EQUIPMENT



Modine Unit Cooler

NAME AND MODEL NUMBERS—Blower type unit cooler, Models 35, 68.
PURPOSE—For cooling stores, offices, and like applications.
FEATURES—Unit filters, cools, dehumidifies, and circulates the air. The blower fan which is incorporated in the unit is said to have a capacity for overcoming external resistance which permits it to be used with duct work if desired. When used without ducts it may be suspended from the ceiling and by using a directional flow grille proper air distribution may be obtained. It is said that the design of this cooler allows it to be completely concealed after installation. It may be installed in a rear room, above a false ceiling or shelving, or in any convenient location. All access to the unit and its parts is from one side of the cabinet. Unit is made in two sizes, 48 in. in length, 17 in. in height and either 25 or 40 in. in width, depending on model. Units are available with either cold water or direct expansion (Freon) cooling coils.
SIZES AND CAPACITIES—Model 35 has a capacity of 26,700 B.t.u. per hr. sensible cooling at 85F d.b. entering air with 40 lb. per min. water flow and 0 in. water external resistance. Model 68 has a capacity of 50,500 B.t.u. per hr. sensible cooling at 85F d.b. entering air with 60 lb. per min. water flow and 0 in. water external resistance.
LITERATURE AVAILABLE—Bulletin 438-A.
MADE BY—*Modine Manufacturing Co., Racine, Wis.* *1*

Kol-Master Stoker

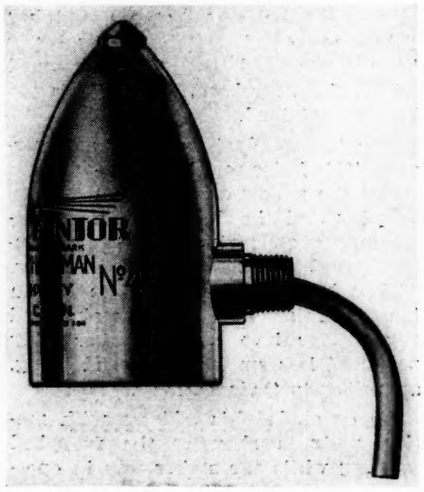
NAME—Challenger.
PURPOSE—Low price domestic stoker for automatic firing of coal.
FEATURES—Dial-set combustion control, reverse-flight feed screw, horizontal feeder plates and smoke-back prevention. Stoker has the same drive, retort, dead plates and totally enclosed motors as the deluxe line. The hopper is of the straight type and is 22 in. high. It has 300 lb. capacity and is centered directly on the feed screw.
CAPACITIES—6 to 40 lb. per hr. burning capacity.
MADE BY—*Kol-Master Corp., Oregon, Ill.* *2*

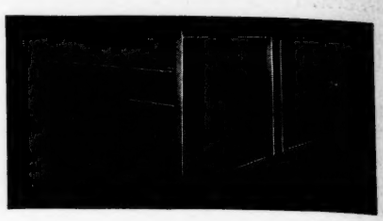
Torrington Fan Blade

NAME—Airistocrat air circulator fan blades.
PURPOSE—A fan blade for producing a high velocity air stream of unusual quietness.
FEATURES—This blade is an addition to the Airistocrat line and has a diameter of 20 in. The manufacturer states that this blade is the result of two years of research and experiment to produce a blade with a lower noise level. The fan is constructed of aluminum alloy blades and steel spiders and hubs. It is made in pitch angles of either 18° or 13°.
SIZES—The Airistocrat line of fans now includes sizes from 8 to 24 in. and will soon include a 30-in. size; 36-, 42- and 48-in. sizes will follow later.
MADE BY—*The Torrington Mfg. Co., 28 Franklin St., Torrington, Conn....3*

Hoffman Radiator Vent Valves

NAME AND MODEL—Radiator vent valves, 40 series.
PURPOSE—Low-priced, quick venting, radiator valves.
FEATURES—These valves were designed with ample capacity to vent radiators quickly. The manufacturer states that the internal construction provides liberal clearances which will prevent dirt from clogging and interfering with the valve action. An important constructional feature is provided in the crimped base construction which is said to be leak proof. The shells of the valves are streamlined to give them a modern appearance and they are nickel plate. The valves are positive in operation and non-adjustable. Valve illustrated is the No. 40 angle pattern.
TYPES AND SIZES—No. 40 angle pattern, size ⅛ in. No. 41 straight shank, ⅛ in. No. 43 straight shank, ¼ in. No. 45 straight shank basement vent, ⅜ in. female, ¾ in. male.
MADE BY—*Hoffman Specialty Co., Inc., Waterbury Conn.*.....*4*





Sturtevant Unit Ventilator

NAME—Auditorium unit ventilator.
PURPOSE—A large capacity unit ventilator for heating and ventilating auditoriums, gymnasiums, assembly halls, and similar large interiors.
FEATURES—Unit consists of an inlet, filter, fan, heater and discharge outlet. Entire assembly is enclosed in a duco finished furniture steel casing. Fresh or recirculated air is drawn through the unit by means of a motor-driven fan located inside the casing. The air passes through a filter and heater and is introduced into the room free from dust and heated to the required temperature. Filters supplied are either of the dry or oil filter type. Units can be installed either horizontally or vertically and can be mounted on the wall or ceiling. Grilles or duct connections on either intake or discharge ends can be supplied if desired.
LITERATURE AVAILABLE—Catalog Supplement No. 377-1.
MADE BY—*B. F. Sturtevant Co., Hyde Park, Boston, Mass.*.....*5*

Bonney Torque Indicating Wrench

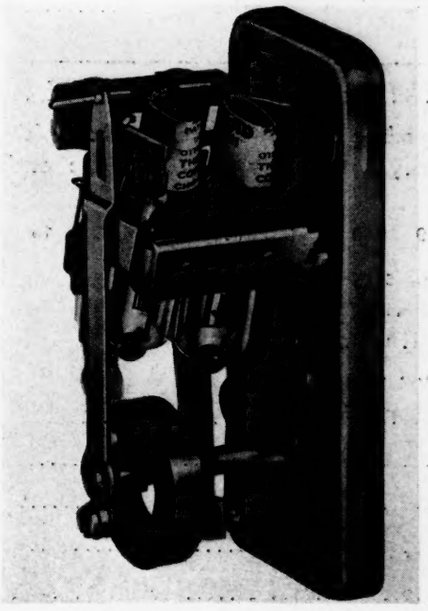
NAME AND MODEL NUMBER—Bonney torque indicating wrench, No. 66.
PURPOSE — For tightening bolts equally.
FEATURES—In using this wrench the indicator is set at the desired torque in foot-pounds which is to be exerted on the bolt. This is done by loosening an indicator clamping screw, moving the indicator to the desired position on the scale and then tightening the screw. The ratchet lever is moved to the extreme left of the wrench. The wrench is then operated as any other ratchet wrench until the ratchet lever snaps to the neutral position in the center. A sharp click is heard and the ratchet locks as a further indication that the desired torque has been reached. It is not necessary to reset the wrench to tighten the next bolt. The manufacturer states that the handle does not swing free when the desired torque is reached, thus preventing smashed fingers. Wrench is equipped with a small head to permit its use in normally inaccessible places.
MADE BY — *Bonney Forge & Tool Works, Allentown, Pa.*.....*6*

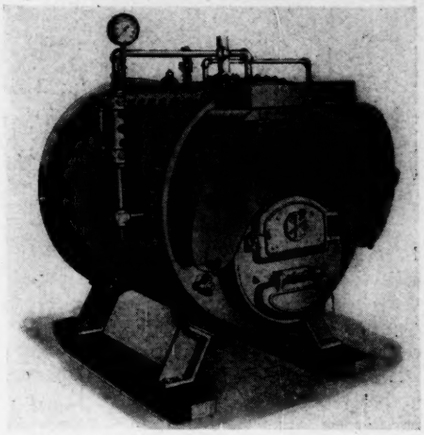
Sprayo-Flake Insulation

NAME—Sprayo-Flake insulation.
PURPOSE—A method of applying fibrous insulating materials to walls, ceilings or equipment to be insulated.
FEATURES—Briefly, the process consists of forcibly projecting, with a specially constructed air gun, dry, fibrous flakes simultaneously with an atomized adhesive. The fibrous flakes are inherently fireproof or have been impregnated with a fireproofing agent. The atomized adhesive coats the fibers as they leave the air gun nozzle and causes them to build up in a homogeneous, cellular mass or blanket upon the surface against which the gun is directed. It is said that Sprayo-Flake can be applied to any surface in any thickness required for effective thermal insulation. The material is available in a number of forms such as Sprayo-Flake thermal insulating blanket, Spray-acoustic or Sprayo-batt. The Sprayo-Flake thermal insulating blanket is gun-applied in any desired thickness directly on walls, ceilings, ducts, or other things to be insulated. Spray-acoustic is also applied with a gun and uses the same material as Sprayo-Flake for a base coat but the absorbing exposed surface is achieved by the introduction of a pastel color in the binder which tints the last fraction of an inch of the material to suit the general decorative scheme. The Sprayo-batt is a combination of rock wool and Sprayo-Flake which seals the rock wool on the inner side of the building construction and prevents the passage of moisture vapor through the wool. The batts are retained permanently in position by spring clips. Standard Sprayo-Flake is composed of dry flakes of fibrous material, impregnated with a fire-resisting agent, atomized emulsified asphalt as a binder and as a surface adhesive, both gun applied, forming a homogeneous, cellular blanket of any desired thickness. The manufacturer states that the material is fireproof and that it has a thermal conductivity of 0.246 B.t.u. per hr. per sq. ft. per in. thickness per degree temperature differential. It is said to weigh approximately 4.6 lb. per cu. ft. installed. When applied on ducts it is said to not only act as a thermal insulation but also reduces to a minimum the transmission of vibration and noise.
MADE BY — *Sprayo-Flake Co., 2715 Irving Park Blvd., Chicago, Ill.*.....7

Mercoid Two Stage Thermostat

NAME—Two Stage Sensatherm.
PURPOSE—For room temperature control on high-low gas or oil burners, for eliminating overshooting temperatures on stokers on forced air systems and for the regulation of two speed fans on air conditioning systems.
FEATURES—When used with a heating system the control operates somewhat as follows: Assuming that the room temperature is above the temperature at which the instrument is set, two switches in the thermostat will have their circuits open. As the temperature starts dropping the first switch or the one controlling the low fire medium will close. If the low fire is sufficient to cause a rise in room temperature, this low fire switch will then open. When the low fire switch is closed and operating the equipment at low fire, should the temperature continue to drop, the second switch, controlling the high fire medium, will then close. As the temperature rises the high fire switch will open but since the low fire switch is still closed, the heating equipment will then operate on a low fire. On cooling type instruments the operation is the same as above except that the circuits close rather than open on a rise in temperature. Maximum capacity of each circuit is 9/10 of an ampere at 24 volts or less.
LITERATURE AVAILABLE—Bulletin No. B-8.
MADE BY — *The Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.*.....8



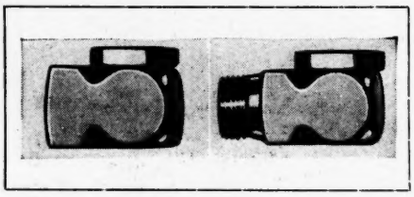


Kewanee Boiler

NAME—Kewanee Scottie Junior Scotch marine boiler.
PURPOSE—For supplying steam at pressures up to 100 lb. per sq. in.
FEATURES—The manufacturer states that this boiler offers high efficiency with low installation cost and a large load-up capacity for the small floor space occupied. The boiler is constructed of a flange steel shell of a cylindrical shape which has one longitudinal joint, double riveted, double butt strap. The tubes are of 12 gage Cop-R-Loy. No brick work is required as the precast refractory insulating blocks are fitted in place at the factory. The boiler is shipped complete with accessories mounted on wood skids and is said to need no foundation settings. Available for burning coal, oil, or gas.
SIZES AND CAPACITIES—Five sizes ranging from 1400 to 4200 sq. ft. of steam radiator surface.
LITERATURE AVAILABLE—Catalog 99.
MADE BY—*Kewanee Boiler Corp., Kewanee, Ill.* 9

Jenkins U-Bolt Valve

NAME—Bronze mounted and all-iron U-bolt gate valves.
PURPOSE—A gate valve with special provision for quick disassembling for inspection or repair.
FEATURES—The manufacturer states that this valve combines quick and easy disassembling for inspection or repair with a higher resistance to springing and distortion. The valve incorporates a renewable "bonnet-saver-bushing" which makes it unnecessary to junk the valve bonnet when operating threads are worn. Another advantage claimed is that because this bushing can be lifted out, the user can get into the upper part of the bonnet chamber to clean out any deposits that form there.
LITERATURE AVAILABLE—Bulletin 179.
MADE BY—*Jenkins Bros., 80 White St., New York*.....10



Spraying Systems

NAME—"Whirljet" spray nozzles.
PURPOSE—For air conditioning, water cooling, air washers, air coolers, brine spraying, heat exchangers in general.
FEATURES—Nozzles are said to be of sturdy construction accurately machined and are designed to produce a uniformly distributed hollow cone spray, highly atomized.
SIZES AND CAPACITIES—With removable cap, male or female pipe connection ⅛ to ¾ in. One-piece construction female pipe connection 1 to 2½ in. with capacities from 0.1 to 107 g.p.m. at 10 lb. pressure.
MADE BY—*Spraying Systems Co., 4922 W. Grand Ave., Chicago, Ill....11*

Healy-Ruff Condensate Return System

NAME—Whitson automatic condensation return and boiler feed system.
PURPOSE—For returning condensation to boilers.
FEATURES—The manufacturer states that this system removes condensation as rapidly as it is formed and returns it to the boiler at high temperatures. When the unit is operating and the tank fills with water, the float switch in the tank automatically starts the motor which in turn opens the steam valve and closes the relief valve. A cam-actuated two circuit mercury switch automatically stops the motor when it has completed this operation. Steam then enters the tank and equalizes the pressure in the tank and the boiler. This causes the water to flow into the boiler by gravity. When the tank is empty the motor automatically closes the steam valve and opens the relief valve, venting the trap. This allows the condensation to flow into the tank. When the tank is again filled, the cycle is repeated.
SIZES AND CAPACITIES—Made in six sizes with capacities ranging from 1200 to 16,000 lb. of water per hr. or from 2300 to 40,000 sq. ft. of direct radiator surface.
MADE BY—*Healy-Ruff Co., 765 Hampden Ave., St. Paul, Minn.....12*

Celotex Duct Insulation

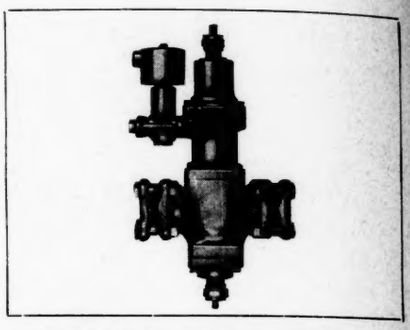
NAME—Q-T. ductliner.
PURPOSE—To absorb air-borne noise, to insulate the duct against thermal loss, to dampen duct wall vibration and to eliminate the "speaking tube" characteristic of duct ventilation.
FEATURES—The liner, which is fabricated of rock wool with a suitable binder, is available in two thicknesses, ½ in. and 1 in., to give a maximum range of sound absorption. For average conditions the manufacturer recommends the ½-in. thickness. The binder employed is said to be impervious to water and water vapor. Acoustical Materials Association laboratory tests assign the following acoustical values:

SOUND ABSORPTION COEFFICIENTS

FREQUENCY	½ IN.	1 IN.
128	0.35	0.43
256	0.25	0.37
512	0.54	0.69
1024	0.75	0.78
2048	0.76	0.78
4000	0.66	0.70
*N.R.C.	0.60	0.70

*The noise reduction coefficient is the average of the coefficients at frequencies from 256 to 2048 cycles inclusive.

MADE BY—*The Celotex Corp., 919 N. Michigan Ave., Chicago, Ill.....13*

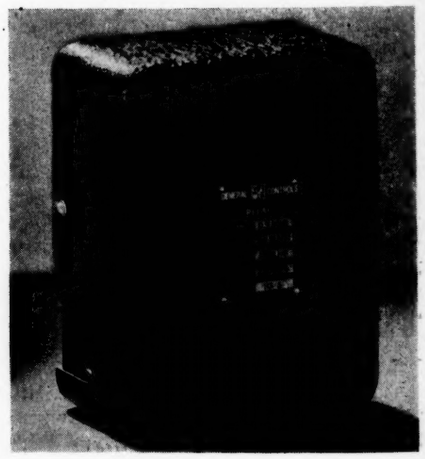


Hubbell Regulator and Valve

NAME AND MODEL NUMBER—Hubbell combination back pressure regulator and suction stop valve SA-3.
PURPOSE—For automatically shutting off suction lines from cooling coils in addition to providing regulation of the pressure within the cooling coils.
FEATURES—This device is said to combine accurate regulation of the back pressure in cooling coils, and by making use of a small electric pilot valve in the control line to the regulator, provides effective shut-off on suction lines beyond the capacity of ordinary electric valves. Flanged connections tapped for pipe thread, or provided with streamline fittings for soldering make this device adaptable for ammonia or Freon service.
SIZES AND CAPACITIES—Made in sizes from ¾ in. to 8 in. port diameter with capacities up to several hundred tons.
MADE BY—*Hubbell Corporation, 1315 Carroll Ave., Chicago Ill.....14*

General Controls Relay

NAME AND MODEL NUMBER—General RS 100.
PURPOSE—A relay capable of handling single phase motor loads up to 1 hp. or heating loads up to 1.5 kw.
FEATURES—The manufacturer states that an exclusive feature of the RS 100 is an extra terminal for supplying power to wall clocks, indicating lamps or small sensitive relays, eliminating the need for a separate low voltage source.
MADE BY—*General Controls Co., 450 E. Ohio St., Chicago, Ill.....15*



TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below circle the item number of the equipment in which you are interested, using the identifying number found at the end of each description

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Fill in your name and address, detach and mail to
HEATING & VENTILATING
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New York, N. Y.

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TAILOR-MADE SHEETS FOR SHEET METAL TAILORS

Keep Costs Down to Estimates

YOUNGSTOWN agrees with the man who knows ductwork. A sheet has got to be just right for this work if layout, cutting, and assembly time are to be kept down to the estimate and profits made.

For this very reason Youngstown galvanized Sheets are tailor made for your class of business. This means that the case history of every single sheet can be traced all the way back to the blast furnace. Step by step its carefully controlled life history can be laid bare. Only by such close and continuous control can absolute uniformity be achieved. This is necessary because there are so many different kinds of steel, and only one is right for you. For this reason Youngstown considers Galvanized Sheets a specialty and has always made them that way. When you buy Youngstown's Galvanized Sheets, you get a sheet that is uniformly ductile and lock seams or radius work can be edged evenly. The finished job bears that stamp of first class workmanship that architects demand and owners judge you by.

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10-5A

Degree-Day Figures for May, 1938

HEATING & VENTILATING continues its tenth year of publishing degree-day data for various large cities

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for May, 1938	234	14	108	7	291	307	344
Degree-days, Sept. 1, '37 to May 30, '38	6206	2834	4178	2442	5895	6643	7608
Degree-days, Sept. 1, '36 to May 30, '37	6083	2727	4141	2367	5665	6571	7475
Degree-days, Sept. 1 to May 30, Normal	6580	2890	4533	2352	6045	6810	7511

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for May, 1938	472	248	124	221	139	288	181
Degree-days, Sept. 1, '37 to May 30, '38	6958	5986	4817	5743	5169	5287	6101
Degree-days, Sept. 1, '36 to May 30, '37	7666	6282	4968	5729	5239	6126	6712
Degree-days, Sept. 1 to May 30, Normal	7340	6290	4703	6155	5398	5874	6384

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for May, 1938	220	137	548	10	264	58	191
Degree-days, Sept. 1, '37 to May 30, '38	6358	4691	9121	2140	6122	4048	6004
Degree-days, Sept. 1, '36 to May 30, '37	6468	5358	9752	2755	5991	4380	6100
Degree-days, Sept. 1 to May 30, Normal	6490	5035	9245	2428	6273	4244	5925

	Fort Worth, Tex.	Grand Rapids Mich.	Green Bay, Wis.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Ithaca, N. Y.
Degree-days for May, 1938	17	243	306	155	237	148	287
Degree-days, Sept. 1, '37 to May 30, '38	2141	6387	7560	5191	5841	5299	6444
Degree-days, Sept. 1, '36 to May 30, '37	2729	6475	7876	5131	5644	5437	6531
Degree-days, Sept. 1 to May 30, Normal	2148	6535	7825	5375	6036	5298	6719

	Kansas City, Mo.	Knoxville, Tenn.	La Crosse, Wis.	Lansing, Mich.	Lincoln, Neb.	Little Rock, Ark.	Los Angeles, Calif.
Degree-days for May, 1938	108	40	240	263	176	15	80
Degree-days, Sept. 1, '37 to May 30, '38	4723	3357	7050	6777	5636	2790	1046
Degree-days, Sept. 1, '36 to May 30, '37	5256	3238	7714	6975	6347	3206	1467
Degree-days, Sept. 1 to May 30, Normal	4852	3670	7322	7048	5999	2811	1504

	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.
Degree-days for May, 1938	70	256	9	330	297	35	229
Degree-days, Sept. 1, '37 to May 30, '38	4233	7058	2826	6662	7700	3353	5557
Degree-days, Sept. 1, '36 to May 30, '37	4446	7551	3199	6972	8316	3531	5397
Degree-days, Sept. 1 to May 30, Normal	4180	7429	2950	7206	7850	3507	5895

	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.
Degree-days for May, 1938	0	178	59	47	171	161	141
Degree-days, Sept. 1, '37 to May 30, '38	1204	4955	3191	3447	5942	5674	4656
Degree-days, Sept. 1, '36 to May 30, '37	1087	4852	3066	3990	6745	6002	4539
Degree-days, Sept. 1 to May 30, Normal	1024	5347	3350	3613	6131	6109	4855

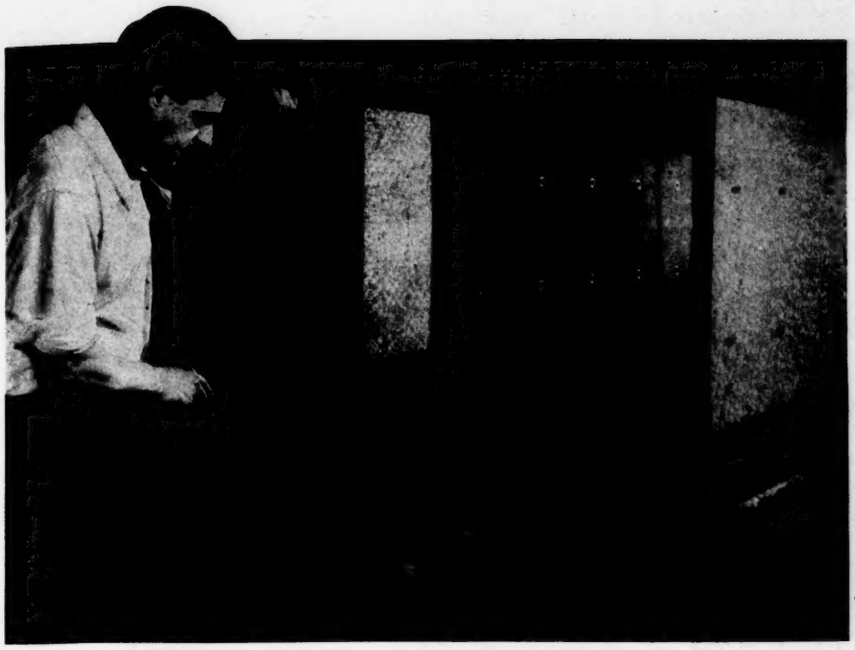
	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.	Reno, Nev.	Richmond, Va.
Degree-days for May, 1938	156	389	223	257	153	288	84
Degree-days, Sept. 1, '37 to May 30, '38	5077	6907	3827	5765	4950	5247	3716
Degree-days, Sept. 1, '36 to May 30, '37	5018	6562	4416	5519	4948	5939	3678
Degree-days, Sept. 1 to May 30, Normal	5235	6973	4379	6015	5389	5802	3727

	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.	Spokane, Wash.
Degree-days for May, 1938	256	85	281	263	221	239	273
Degree-days, Sept. 1, '37 to May 30, '38	6387	4374	4723	2448	5912	3934	5604
Degree-days, Sept. 1, '36 to May 30, '37	6319	4768	5946	2802	5900	4583	6783
Degree-days, Sept. 1 to May 30, Normal	6732	4585	5555	2681	6129	4715	6274

	Springfield, Ill.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for May, 1938	126	249	201	173	288	118	114
Degree-days, Sept. 1, '37 to May 30, '38	5080	6243	6000	5060	6948	4257	4392
Degree-days, Sept. 1, '36 to May 30, '37	5411	6225	6122	4959	6538	4207	4986
Degree-days, Sept. 1 to May 30, Normal	5373	6881	6077	4933	6796	4626	4673

Methods of applying the degree-day in connection with the operation of heating plants or for the prediction of fuel consumption of heating plants are described fully in the new enlarged edition of the DEGREE-DAY HANDBOOK, published by HEATING & VENTILATING, 148 Lafayette Street, New York, price $3. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

STOPS FIRE *as well as* NOISE



DANGER of fire starting and spreading in duct linings is too serious a question to overlook.* Particularly when it can be avoided with a lining material that combines unusually high sound-absorption qualities with complete fire-safety.

J-M Airacoustic Sheets do exactly that. Entirely mineral in composition, they provide as high as 70% sound-absorption. And they *cannot burn or smolder* . . . will not contribute to the spread of fire.

Moreover, J-M Airacoustic Sheets are light in weight . . . easily handled and easily applied. Their transverse strength is high, thermal conductivity low. And, because Airacoustic Sheets are highly resistant to moisture, they are exceptionally free from the dangers of humidity.

Get all the facts. They'll show you how you can use J-M Airacoustic Sheets on all your duct-lining jobs to both your clients' and your own advantage. For full details, write Johns-Manville, 22 East 40th St., New York, N. Y.

*A recent bulletin from the National Board of Fire Underwriters reports several cases of this very nature.

Johns-Manville

AIRACOUSTIC SHEETS FOR DUCT LINING

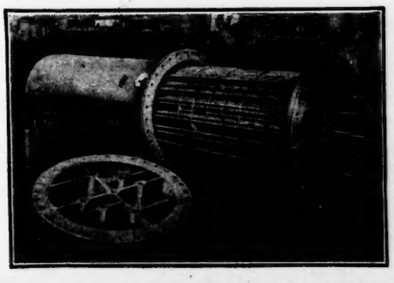
Patterson Freon Water Coolers

Patterson Water Coolers are the peak of mechanical excellence achieved through more than half a century of experience in heat transfer equipment.

They offer the most efficient and economical method of cooling water in closed or open circuits with Freon or similar refrigerants.

Patterson Coolers insure the proper operation of the thermo expansion valve by always delivering superheated gas to the suction line. The U-tube construction eliminates all possibility of leaks from expansion and contraction and permits easy removal of the entire tube bundle.

Patterson Coolers are divided into as many circuits as there are compressors so as to provide permanent segregation of refrigerant charges for each compressor.



For further particulars write for catalog.

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The Conduit for Underground Steam Lines

SIMPLEST
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Sold and Installed by Johns-Manville Construction Units in all Principal Cities.

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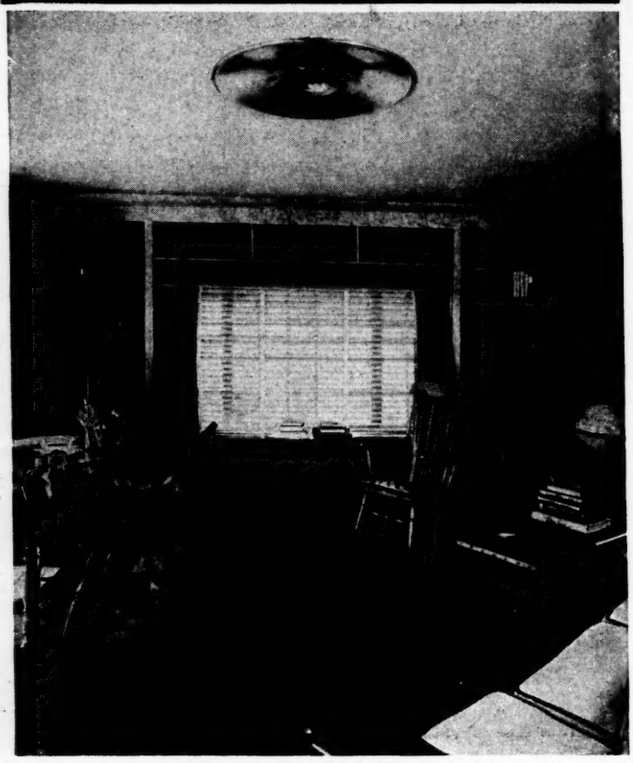

E. E. Ashley, *Consulting Engineer*
Nassau Engineering Co., *Contractors*

This handsome private library and study of Harold R. Medina, Esq., located on the shore of Long Island is completely air conditioned for both winter and summer use. Whether used for concentrated study or reading for recreation a library must be free from disturbing and harmful drafts. Furthermore, there must be no hot or cold spots which means that the temperature must be equalized. One Anemostat in the main room shown here, and three smaller Anemostats, one in each of the book alcoves, completely solved the air distribution problem on this job. The Anemostat is an accepted scientific achievement. It has solved the major problems of the Air Conditioning Industry by reducing the speed of air flow to such an extent that it is no longer perceptible as a draft and by mixing room air with conditioned air within the device. Its use, therefore, permits greater temperature differentials, smaller ducts, smaller plants, lower installation and operating costs. The Anemostat can be applied to existing systems as well as to new installations.

INSTALLATION DATA

MAIN READING ROOM—
Length 18'-6" Width 15'-6"
Height of ceiling 9'-3"
One type "C" Anemostat 12" neck diameter
Heating 500 c.f.m. at 637 f.p.m.
Cooling 900 c.f.m. at 1146 f.p.m.
Maximum temperature differential for heating 50°
Maximum temperature differential for cooling 15°

EACH BOOK ALCOVE—
Length 13'-0" Width 9'-0"
Height of ceiling 9'-3"
One type "B" Anemostat 5" neck diameter
Heating 75 c.f.m. at 550 f.p.m.
Cooling 150 c.f.m. at 1100 f.p.m.

ANEMOSTAT CORPORATION OF AMERICA
10 EAST 39TH STREET, NEW YORK

ANEMOSTAT
"No Air Conditioning System is better than its Air Distribution"

AN-11

NEW TRADE LITERATURE

Air Conditioning Supplies. A standard-size, 96-page catalog on air conditioning and refrigeration parts, tools and supplies. This is the 1938 mid-season catalog and following a policy established last year, contains list prices throughout. Twelve new pages have been added and Chicago seals, Gilmer belts, Arco fittings and Kerotest valves are among the new items added. Aero Supply Co., 2732 N. Ashland Ave., Chicago, Ill.....16

Air Filters. A standard-size looseleaf folder containing a number of catalogs describing the Independent Line of air filters. The catalog describes the Double-Duty Model L automatic self-cleaning filter, Kompak Model C dry fabric type, and the Permo flame-proof throw-away type air filter. Independent Air Filter Co., 228 N. La Salle St., Chicago, Ill. 17

Controls. A pocket-size, 116-page bulletin, No. 733, containing specifications and data pertaining to Ranco controls for heating, cooling and commercial refrigeration. Gives the following information on each type of instrument: description, specifications, current rating and dimensions. Also includes wiring diagrams, service hints and instructions for all Ranco controls. Ranco Inc., 601 W. Fifth Ave., Columbus, Ohio.....18

Fans. A standard-size, 52-page catalog describing Propellair fans. Gives information on direct connected fans, window and kitchen ventilating fans, louvers, guards, aluminum fans, V-belt drive fans, extension shaft fans, man-cooling fans. Also includes considerable amount of general information and engineering data including charts to show the air horsepower or horsepower required to drive fans, friction loss in ductwork, friction loss in elbows and ventilating terms and definitions. Propellair, Inc., Springfield, Ohio.....19

Heating Systems. A standard-size, eight-page catalog covering the Hoffman new hot water controlled heat system. Operation of the system is described and illustrated so that the layman as well as the engineer, architect, and contractor will understand the new principles involved. Hoffman Specialty Co., Inc., Waterbury, Conn. 20

Instrument Boards. A standard-size bulletin, No. 223, describing Foxboro instrument boards. Gives information on instrument and control board design, illustrations of several characteristic Foxboro installations, brief descriptions and diagrammatic layouts of standard arrangements and panel sizes for various instruments. The Foxboro Co., Foxboro, Mass.....21

Pipe Fittings and Valves. A standard-size, cloth bound, 602-page catalog, No. 89, covering the complete line of Walworth valves, fittings, pipe and tools. Added features are embodied in this new edition which should render it of increased usefulness to engineers, contractors, and others interested in the Walworth line of products. New sections cover lubricated plug valves, Walseals, Hi-Test cast iron pipe, fabricated pipe, piping design and engineering data. Copies of catalog available to those who request them on their company letterhead. Walworth Co., New York.....22

Pipe Welding. A standard-size, 12-page bulletin describing the arc welding of piping for operation at pres-

sures up to 1500 lb. per sq. in. and temperatures up to 1000F. In addition to the selection of pipe materials and welding electrodes, this bulletin describes welding design, welding procedure, preheating, stress relieving, testing of welds and the qualification of welding process and welding operators. METAL & THERMIT CORP., 120 BROADWAY, NEW YORK. 23

Sheet Metal. A small size folder on Beth-Cu-Loy sheets. These sheets are made of a special open-hearth steel alloyed with copper to give a maximum resistance to corrosion. Folder gives results of three sets of tests made to determine the resistance of these types of sheets to corrosion. BETHLEHEM STEEL CO., BETHLEHEM, PA. 24

Steam Traps. An illustrated four-page, two-color bulletin, No. 35-86, giving details of construction and installation hookups on the Adsco vertical float type steam trap with or without thermostatic bypass. AMERICAN DISTRICT STEAM CO., NORTH TONAWANDA, N. Y. 25

Stokers. A standard-size, eight-page bulletin, No. 77, describing the Fyr-Feeder coal burner. This coal burner is of the multiple spreader type. Bulletin gives information on the features of construction and shows how the stoker is readily adaptable to various types of boilers. AMERICAN COAL BURNER CO., 155 E. SUPERIOR ST., CHICAGO, ILL. 26

Stokers. A 24-page catalog, No. 300, covering the entire line of Kol-Master domestic, commercial, institutional and industrial models ranging from 30 to 1600 lb. per hr. capacity. Contains description of all details of Kol-Master features of design, construction and operation. This manufacturer has also published an eight-page booklet covering the Kol-Master S models for Scotch marine and other long, narrow firebox boilers and furnaces. KOL-MASTER CORP., OREGON, ILL. 27

V-Belts. A standard-size, four-page bulletin, No. 6868, presenting information on the technical details of the functions and construction of V-belts. Includes photographs of V-belt installations, as well as list prices and V-belt comparison table. THE MANHATTAN RUBBER MFG. DIV. OF RAYBESTOS-MANHATTAN, INC., PASSAIC, N. J. 28

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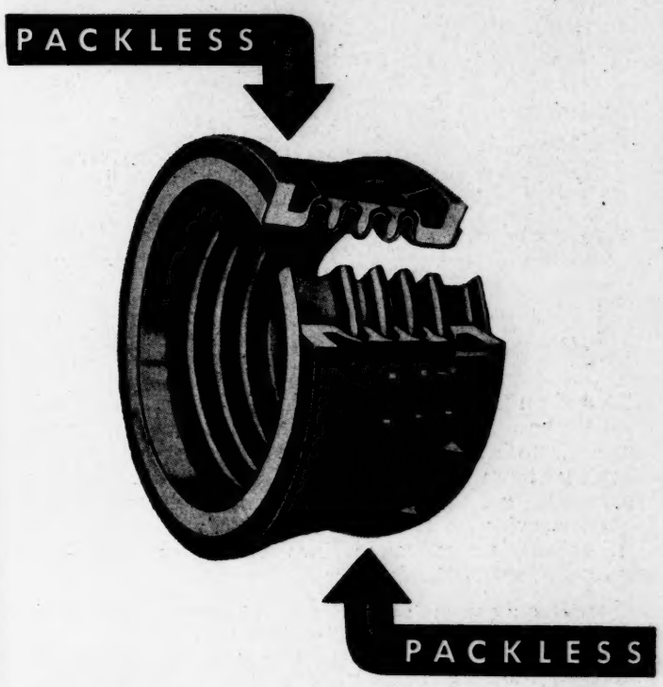
BADGER
EXPANSION JOINTS



"Packless"..and the Copper Expansion Joints Take Care of Traverses Ranging from Fractions of an Inch up to 12 ins.

These two features of the present line of BADGER Directed Flexing, Self Equalizing Expansion Joints mean definite economies in taking care of pipe-line expansions.

"Packless" . . . that tells its own story of joints that need no servicing after being installed.

"Wide Range of Traverses" . . . in simplest terms this means that in any desired size there is a BADGER Expansion Joint that will handle the traverse involved with an ample margin of safety. Traverses range from fractions of an inch up to 6" single and 12" double.

Bulletin No. 100, just issued, gives full details. Send for a copy.

Bulletin No. 200 describes the BADGER Non-Equalizing Expansion Joints; Bulletin No. 300 describes the Pipe Line Flexible Seals.

E. B. BADGER & SONS CO.
75 PITTS STREET
BOSTON, MASS.
Agents in Principal Cities.

CATCH HIM!

STEAM on the loose is as suicidal as permitting a valuable thoroughbred horse to roam Michigan Avenue alone through motor traffic. Runaway horse power and escaping steam mean somebody's *money lost.* Conserve steam, cut fuel costs, reduce repairs, and assure satisfactory service on the *delivery* end of steam lines—by putting your underground lines where they belong—in genuine Ric-wiL Conduit.

Ric-wiL is a pre-engineered sectional system built of vitrified tile (also furnished in Cast Iron and in Armco Iron Units). Standard Ric-wiL is insulated with patented Dry-paC waterproof asbestos (sectional pipe covering optional). Exhaustive tests prove that Ric-wiL with Dry-paC delivers over 90% efficiency *on the line.* Ric-wiL provides closed construction, efficient drainage, and opportunity for inspection during installation. Ask for latest Bulletin describing Ric-wiL complete conduit service.

The RIC-WIL Co., Union Trust Bldg., Cleveland, Ohio

New York San Francisco Chicago

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● Ric-wiL's 28 years experience is really underground steam INSURANCE—costs you NOTHING!

RIC-WIL Type F Conduit

REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

ANSWERS TO THE QUESTIONS ON PAGE 58

1. The Ringelmann chart is an arbitrary scale of smoke density, so that (1) is correct.

2. As the pressure on water increases above atmospheric the freezing point of water decreases 0.0133F for each additional atmospheric pressure, so that (3) is correct.

3. A eupatheoscope measures the rate of heat necessary to offset the heat lost from a human being. Correct answer is (4).

4. The wet bulb temperature. (3) is correct.

5. The SO_2 is condensed out in the first chamber where CO_2 is absorbed, so that the per cent SO_2 is indicated with the CO_2. (5) is correct.

SUMMER DEGREE-HOURS (ABOVE 85F) MAY, 1938

City	May, 1938	May, 1937	Year, 1938 to May 31	Year, 1937 to May 31
Baltimore	0	61	6	61
Birmingham	103	304	103	307
Bismarck	0	43	0	43
Boston	0	48	19	48
Buffalo	2	0	2	0
Chicago	11	45	11	45
Cincinnati	4	106	4	106
Cleveland	0	7	0	7
Columbus	12	52	12	52
Des Moines	0	14	0	14
Detroit	0	35	0	35
Fort Wayne	1	33	1	33
Grand Rapids	3	51	3	51
Houston	71	160	71	163
Indianapolis	0	82	0	82
Kansas City	11	65	12	65
Memphis	37	222	37	224
Milwaukee	0	12	0	12
Minneapolis	0	20	0	20
New Orleans	105	198	105	198
New York	0	9	0	9
Philadelphia	0	22	1	22
Pittsburgh	1	18	2	18
Portland, Oreg.	34	0	34	0
Richmond, Va.	45	80	46	104
St. Louis	8	109	17	137
San Diego	0	0	0	0
San Francisco	0	0	0	0
Savannah	419	204	567	234
Toledo	7	36	7	36
Washington	2	33	14	69

COMING EVENTS

JULY 20, 1938. Second regular meeting, National Association of Fan Manufacturers, Detroit. L. O. Monroe, secretary, 5-208 General Motors Bldg., Detroit.

SEPTEMBER 21-23, 1938. 16th Annual Conference, National Industrial Advertisers Association, Cleveland, Ohio. Stanley Knisely, Advertising Manager, Republic Steel Corp., Cleveland, Ohio.

DECEMBER 5-10, 1938. 13th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

JANUARY 23-27, 1939—Annual Meeting, American Society of Heating and Ventilating Engineers, Pittsburgh, Pa.

WITH THE MANUFACTURERS

Conoco-Sampsel Stoker Corp., Mendota, Ill., has named *Nellor-Prather Co.*, 2518 Farnum St., Omaha, Neb., exclusive distributor of its stokers in Nebraska and northern Iowa. *Baker Specialty and Supply Co.*, Logansport, Ind., is distributor in the northern Indiana territory.

Crane Co., Chicago, has named *L. B. Hampton* manager of the Pacific Northwest district, with headquarters at Portland, Oreg. The district includes Washington, Idaho, nearly all of Oregon and Utah and parts of Nevada, Montana, and Wyoming. *Robert C. Smith* succeeds Mr. Hampton as manager of the Portland branch.

The McAlear Mfg. Co., 1901 S. Western Ave., Chicago has named *Earl G. Embree* representative in North and South Carolina handling the company's vapor and vacuum heating specialties. *Charles M. Setzer & Co.* will handle the company's industrial and power plant equipment in that territory. Both will have headquarters in Charlotte.

Philco Radio & Television Corp., 3701 N. Broad St., Philadelphia, will sell exclusively through its dealers the Cool-Wave portable air conditioning unit, manufactured by York Ice Machinery Co.

L. J. Wing Mfg. Co., 154 W. 14th St., New York, has named *Lloyd C. Taylor*, Richmond, Va., in charge of sales for that territory.

York Oil Burner Co., Inc., York, Pa., has been purchased outright by *Thomas Shipley, Inc.* York Oil Burner has been manufacturing domestic oil burning equipment for nearly twenty years. Six years ago the company purchased all of the Lalor patents on industrial equipment. *A. J. Seiler* is now president of York. Thomas Shipley, Inc., is owned and operated by the descendants of the late Thomas Shipley, prominent in the refrigeration field. The following personnel has remained unchanged: vice-president, *E. I. Kraber;* secretary-treasurer, *L. H. Brenneman;* general sales manager, *Lawrence Knapp.*

ANSWER TO THE PROBLEM ON PAGE 58

Let X = No. of hours required to fill tank with old supply pipe

and Y = No. of hours required to empty tank with old drain pipe

and V = Volume of tank

$$\text{Then } \frac{V}{X} = \text{rate of inflow, and } \frac{V}{Y} = \text{rate of outflow}$$

$$\text{Whence } \frac{V}{2} + \frac{12V}{X} - \frac{12V}{Y} = 0$$

$$\text{and } \frac{V}{2} + \frac{15\frac{3}{4}V}{X+1} - \frac{15\frac{3}{4}V}{Y+1} = 0$$

By eliminating V from these equations and solving, we get X = 8 hr. = time to fill tank with old supply pipe, and Y = 6 hr. = time to empty tank with old drain pipe.

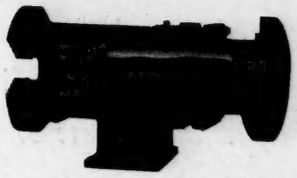
CHOOSE YOUR EXPANSION JOINTS FROM THE COMPLETE ADSCO LINE

Piston-Ring Type Joint

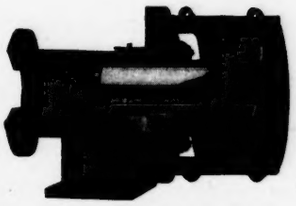
THERE IS A SIZE AND TYPE FOR YOUR EVERY PIPING NEED

Hundreds of ADSCO Expansion Joints are in daily service on high pressure, high temperature lines. They are available in semi-steel, cast steel or bronze single or double joints in various traverses with flanged or beveled ends for welding.

Submit bill of materials for prompt estimates of cost or request descriptive bulletins giving details of construction. Write to Dept. V.



Internally Guided Joint



Internally-Externally Guided Joint

Riser Type Expansion Joint

Duplex-Sleeve Type Joint

AMERICAN DISTRICT STEAM COMPANY

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IN BUSINESS OVER SIXTY YEARS